

5. Bike Facility Design Options



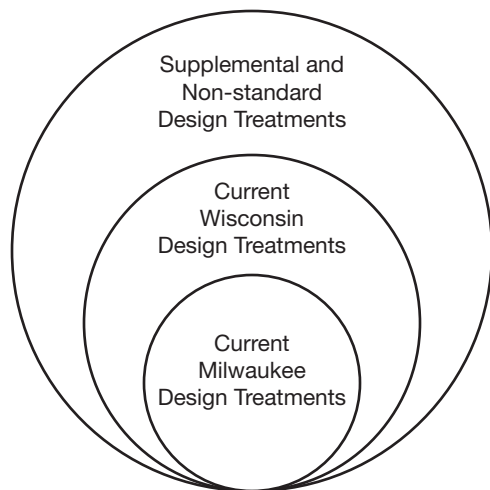
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5. Bike Facility Design Options

This chapter details bicycle facility design options for the city of Milwaukee. The facilities detailed here build upon current state and federal design guidelines, as well as non-traditional design treatments that may not be found in current guidance. The *City of Milwaukee Bicycle Lane Design Guide*, the *Wisconsin Facilities Development Manual (FDM)*, the *Wisconsin Bicycle Facility Design Handbook*, and the Federal Highway Administration's *Manual on Uniform Traffic Control Devices (MUTCD)* should all be consulted before implementing new facilities.

This chapter begins with a discussion of three levels of design treatments:

- Current Milwaukee design treatments that require updates to meet current best practices or reflect the most current research.
- Treatments that are included in the Wisconsin Bicycle Facility Design Handbook but not included in the city's Bike Lane Design Guide.
- Treatments that are currently in use or under study in other parts of the country but are not included in the Wisconsin Bicycle Facility Design Handbook. These facilities may require experimental status from the Federal Highway Administration, a process that is outlined in Appendix M.



In general, each level of treatments encompasses the previous level, as shown in the diagram below.

Specific design treatments comprise the bulk of this chapter. These treatments include a summary of the facility design, a discussion of when the design should be used and the benefits it provides, and graphical illustrations of each design treatment. The design design

treatments begin with facilities currently in use in Wisconsin and then turn to non-traditional facilities.

Current Milwaukee Design Treatments

In general, treatments currently included in the city of Milwaukee standard design guidelines are consistent with the federal standards contained in the FHWA's *Manual on Uniform Traffic Control Devices (MUTCD)* and anticipated updates to American Association of State and Highway Transportation Officials' (AASHTO) *Guide for the Development of Bicycle Facilities*. These facilities have been updated to ensure that they conform to standards contained in editions of the MUTCD and *Guide for the Development of Bicycle Facilities*.

Bike Route Striping/Shared Lane Marking

The city's *Bike Lane Design Guide* contains a standard pavement marking symbol to be painted on bike routes. The design closely resembles that of a Shared Lane Marking or "sharrow" that provides visual clues for cyclists about where they should travel within the roadway to avoid the doors of parked vehicles. This treatment design should follow guidance included in the 2009 MUTCD design guidelines and be renamed to 'Shared Lane Markings' for consistency with other bikeway design standards.

Current Wisconsin Design Treatments

Treatments listed below are identified in Wisconsin State guidelines (the FDM and the Wisconsin Bicycle Facility Design Handbook) but not in the city's guidelines (e.g., shared use paths). It is recommended that the city follow the State of Wisconsin's guidance in these situations. It should be noted that Wisconsin guidelines will be updated to conform to standards contained in the 2009 FHWA Manual on Uniform Traffic Control Devices and anticipated updates to American Association of State and Highway Transportation Officials' (AASHTO) *Guide for the Development of Bicycle Facilities*.³ Any projects receiving State or Federal funding must meet the standards described in the Wisconsin Bicycle Facility Design Handbook.

³ Anticipated to occur in 2010.

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Shared Use Paths

In the absence of city-wide design guidelines for shared use pathways, Milwaukee should adopt Wisconsin State guidelines. The current State guidelines provide information on:

- Suggested pathway dimensions
- Sidewalk bikeways
- Design considerations (e.g., design speed, pavement structure and sight distance)
- Intersection design (e.g., path-roadway crossings)
- Lighting
- Signing and marking
- Overpasses and underpasses
- Design of pathways next to roadways
- Interactions of bicycles and other shared use pathway users (e.g., pedestrians, horses and motor vehicles)

Detailed Design Guidance for On-Street Facilities

State guidelines contain supplemental guidance for on-street facilities; the city should consider this guidance in design of all future on-street facilities. This information covers details of:

- Railroad crossings
- Wide outside lanes
- Paved shoulders
- Bridges and interchanges
- Pavement quality
- Drainage grates and utility covers
- Intersection design
- Traffic calming
- Bicycles and traffic signals (i.e., bicycle detection, signal loop markings, signal timing and programmed signal heads)
- Left turn bicycle lanes
- Intersections with right-turn lanes

Contra-Flow Bicycle Lane on One-Way Street

Contra-flow bicycle lanes enable bicyclists to ride in the opposite direction of vehicle traffic on one-way streets. Pilot project status and other case studies should be reviewed to determine the status of this design treatment. Several US cities have existing contra-flow bike lanes.⁴

Shared Bicycle/Right-Turn Lane

Places a standard width bicycle lane within a standard right-turn lane. A dashed line delineates space for motorist and bicyclist ensuring proper positioning for bicyclists at intersections.⁵

Supplemental and Non-standard Design Treatments

The treatments listed below are not currently found in the city or State standards, are not included in the MUTCD and are sometimes considered “non-standard.” These treatments are recommended for consideration and possible use by the city. Many of these treatments cover specific situations intended to create safer travel conditions for cyclists, pedestrians and motorists alike. Non-standard treatments can be used when standard bicycle facility treatments do not fit the context of the existing built environment (e.g., narrow rights-of-way or off-angled intersections).

Wide Bicycle Lane Next to On-Street Parallel Parking

Wide bicycle lanes increase the safety of the facility. An update to lane width would be necessary to meet with current best practices.

Bicycle Lane Next to On-Street Diagonal Parking

This treatment improves line-of-sight between motorists and bicyclists, increasing safety for all users. The treatment requires the use of reverse (back-in) diagonal parking that requires motorists to back in to parking spaces.

Bicycle Boulevard

Bicycle boulevards create on-street travel conditions for cyclists that do not wish to ride in bicycle lanes or may

⁴ Treatment included in state guidelines but not in the MUTCD.

⁵ Treatment included in state guidelines but not in the MUTCD.

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not feel comfortable on streets with more motor vehicle traffic. Bicycle boulevards are ideal for streets with relatively low traffic volumes and posted speeds that enable cyclists and motorists to share the same travel lanes.

Bicycle Only Left Turn Pocket

Creates a buffered space in the median accessible only to bicyclists allowing for safe left turning movements.

Bicycle Lanes at Double Right-Turn Intersections

Location of the bike lane prevents motorists in the outside turn lane from turning into bicyclists traveling forward through the intersection.

Colored Bicycle Lanes In Conflict Areas

Colored bicycle lanes alert motorists to approaching conflict areas and help guide bicyclists through difficult transitions.

Bicycle Lanes at Interchanges

Where bicyclists and motorists merge together it may be necessary to provide increased visibility through coloring and/or striping techniques and signage.

Colored Bicycle Lanes

A contrasting color for sections of bicycle lane helps to better delineate space for bicyclists on the roadway.

Bicycle Box – Single Lane - No Vehicle Right Turns

A bicycle box is an extension of the bike lane located at the head of an intersection that can reduce the risk of “right hook” conflicts between motorists and bicyclists by making cyclists more visible to motor vehicles. Motorists are stopped behind an advanced stop bar and restricted from making right turns on red. Bicyclists are able to move to the front of the queue and are the first to move on green.

Bicycle Box – Multi Lane - No Vehicle Right Turns

The same as above, however, this treatment works best to allow bicyclists to make either right or left turn movements ahead of traffic.

Bicycle Box – Multi-Lane - Right Turns Allowed

In some cases bicycle access in unnecessary or restricted and a right-turn only lane for motorists may be provided that does not interfere with bicyclists.

Raised Bicycle Lanes

Raised bicycle lanes have several benefits: they provide a visual and tactile reminder to drivers, provide an element of separation between fast moving traffic and the bike lane, and they have lower maintenance costs due to reduced travel wear.

Cycle Tracks

A cycle track is a hybrid type bicycle facility that combines the experience of a separated path with the on-street infrastructure of a conventional bicycle lane. They provide space that is intended to be exclusively or primarily for bicycles, and is separated from vehicle travel lanes, parking lanes and sidewalks by pavement markings or coloring, bollards, curbs/medians or a combination of these elements.⁶

Detailed Design Treatments

The remainder of this chapter details the design treatments outlined above. Each section provides a summary and discussion of the design treatment as well as photographs or illustrations of the treatment. Some treatments provide best practices related to the treatment as well as municipalities where the treatment has been used.

Illustrations and photographs provided in this section are informational and should not be treated as engineering diagrams. Specific projects should be evaluated on a case-by-case basis for the appropriateness of the proposed treatment and the design modifications that may be necessary.

⁶ Wisconsin Bike Facility Design Guidelines state that bike lanes should never be placed between parked cars and the curb due to the increased difficulty of turning maneuvers and increased potential of conflicts at driveways and intersections. New cycle track design guidelines create a facility similar to a bike lane placed between a parking lane and travel lane. Following updated guidelines and carefully considering where installation of this type of facility is appropriate can reduce conflicts and increase safety of all parties sharing the right-of-way.

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Shoulder Bikeways

Design Summary

Typically found in rural areas, shoulder bikeways are paved roadways with striped shoulders (4'+) wide enough for bicycle travel. Shoulder bikeways often, but not always, include signage alerting motorists to expect bicycle travel along the roadway.

Discussion

In some cases, the opportunity to develop a standard bike lane on a street where it is desirable may not be possible. However, it may be possible to stripe the shoulder in lieu of bike lanes by reducing the outside lane width to the AASHTO minimum. If the resulting shoulder bikeway width is 2/3 of the desirable bike lane width, the full bike lane treatment of signs, legends, and an 8" bike lane line should be provided. Where feasible, extra width should be provided with pavement resurfacing jobs, but not exceeding desirable bike lane widths.

Wide Outside Lanes

A wide outside lane (14'-15') may be sufficient accommodation for bicyclists on streets with insufficient width for bike lanes.



Shoulder bikeways are appropriate along wide rural roads where vehicles can avoid passing close to bicyclists

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Bike Lanes

Design Summary

Designated exclusively for bicycle travel, bike lanes are separated from vehicle travel lanes with striping and also include pavement stencils. Bike lanes are most appropriate on arterial and collector streets, where higher traffic volumes and speeds warrant greater separation.

Discussion

Most commuter bicyclists would argue that on-street facilities are the safest and most functional facilities for bicycle transportation. Bicyclists have stated their preference for marked on-street bike lanes in numerous national surveys. The fact is that many bicyclists – particularly less experienced riders – are far more comfortable riding on a busy street if it has a striped and signed bike lane. Part of the goal of this Plan is to encourage new riders, and providing marked facilities such as bike lanes is one way of helping to persuade residents to give bicycling a try.

If properly designed, bike lanes can increase safety and promote proper riding. For this reason, bike lanes are desirable for bicycle commute routes along major roadways. Bike lanes help to define the road space for bicyclists and motorists, reduce the chance that motorists will stray into the cyclists' path, discourage bicyclists from riding on the sidewalk, and remind motorists that cyclists have a right to the road. One key consideration in designing bike lanes in an urban setting is to ensure that bike lanes and adjacent parking lanes have sufficient width so that cyclists have enough room to avoid a suddenly opened vehicle door.

Additional Guidance

The AASHTO Guide for the Development of Bicycle Facilities notes that “longitudinal pavement markings should be used to define bicycle lanes.” The guideline states that “if used, the bicycle lane symbol marking shall be placed immediately after an intersection and other locations as needed. The bicycle lane symbol marking shall be white. If the word or symbol pavement markings are used, Bicycle Lane signs shall also be used, but the signs need not be adjacent to every symbol to avoid overuse of the signs.”

The following pages describe guidelines for implementing bike lanes on streets with on-street parking (both parallel and diagonal) and without parking. Additional sheets highlight particular considerations for bike lanes, including conflicts with right-turning motorists, left-turning bicycle movements, bike lanes at intersections, and innovative techniques for improving bike lane visibility (including colored bike lanes and bike boxes). The following sections discuss a variety of methodologies for retrofitting bike lanes to existing roadways.



Bike lanes with signage on a popular commuting and recreational route in California



Bike lane pavement markings in Portland, OR provide character to the roadway

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Bike Lane Configurations

Bike Lane Adjacent to On-Street Parallel Parking

Design Summary

Bike Lane Width:

- 5' recommended
- 7' maximum (may encourage vehicle loading in bike lane)

Discussion

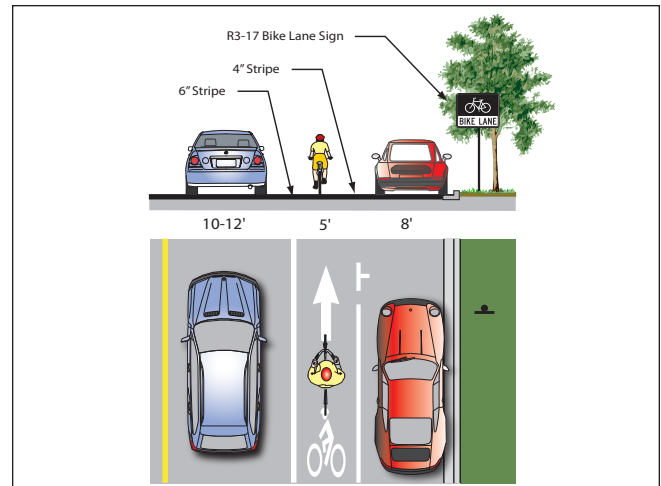
Bike lanes adjacent to on-street parallel parking are common in the United States and can be dangerous for bicyclists if not designed properly. Crashes caused by a suddenly opened vehicle door are a common hazard for bicyclists using this type of facility. Wide bike lanes may encourage the cyclist to ride farther to the right (door zone) to maximize distance from passing traffic. Wide bike lanes may also cause confusion with unloading vehicles in busy areas where parking is typically full. Some alternatives include:

- Installing parking "T's" and smaller bike lane stencils placed to the left (see graphic at top right).
- Using diagonal stripes to encourage cyclists to ride on the left side of the bike lane (shown middle right; this treatment is not standard and should be studied before use)
- Provide a buffer zone (preferred design; shown lower right) Bicyclists traveling in the center of the bike lane will be less likely to encounter open car doors. Motorists have space to stand outside the bike lane when loading and unloading

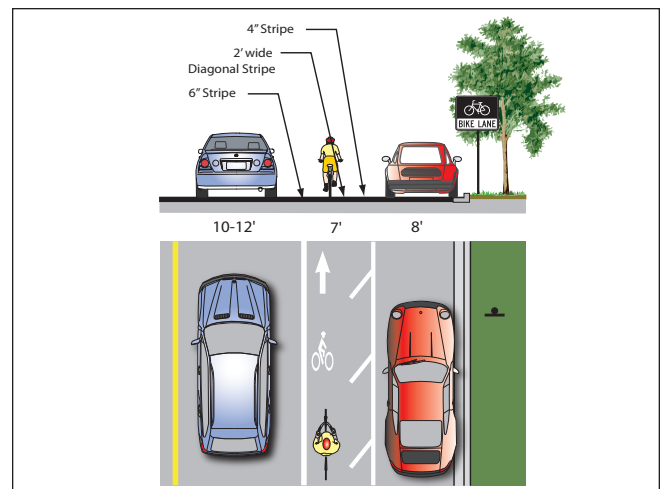
AASHTO Guide for the Development of Bicycle Facilities provides additional guidance for bike lanes adjacent to on-street parking:

- "If parking is permitted, the bike lane should be placed between the parking area and the travel lane and have a minimum width of 5'. Where parking is permitted but a parking stripe or stalls are not utilized, the shared area should be a minimum of 11' without a curb face and 12' adjacent to a curb face. If the parking volume is substantial or turnover is high, an additional 1'- 2' of width is desirable."

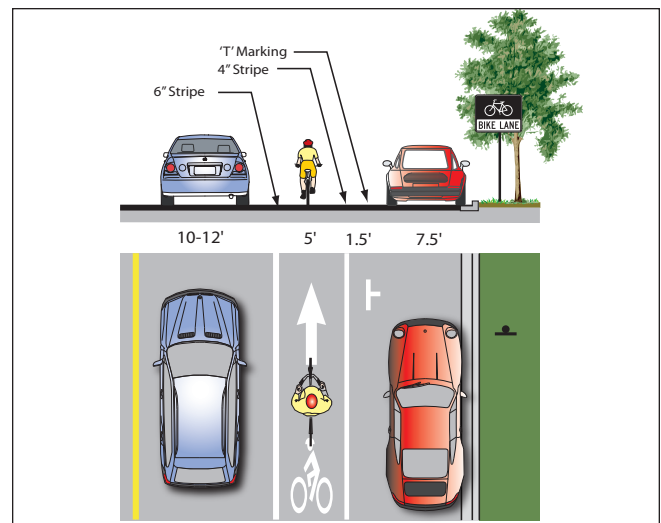
In generally, a minimum of 13' combined space (5' bike lane and 8' parking lane) should be provided. A 12' combined space should only be considered where parking turnover is extremely low.



Minimum Design



Maximum Width



Preferred Design (if space is available)

5. Bike Facility Design Options

Bike Lane Configurations

Bike Lane Without On-Street Parking

Design Summary

Bike Lane Width:

- 4' minimum when no gutter is present (rural road sections)
- 5' minimum when adjacent to curb and gutter

Recommended Width:

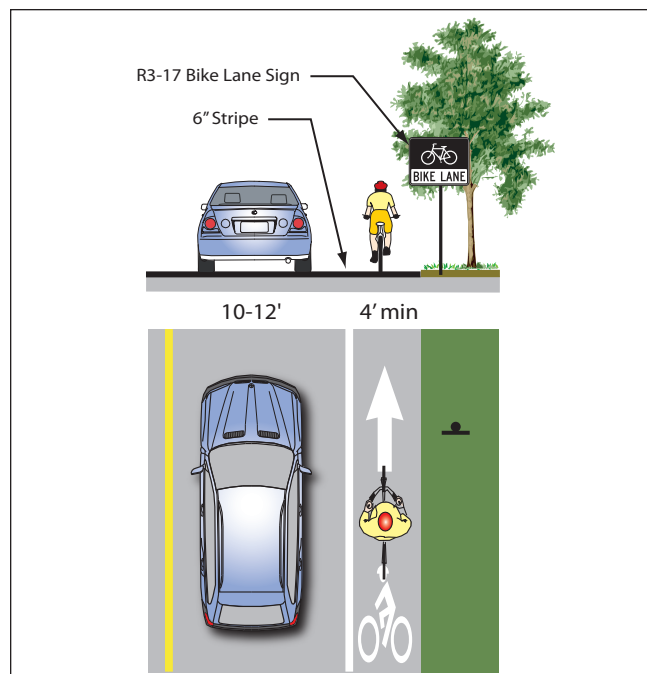
- 6' where right-of-way allows

Maximum Width:

- 8' Adjacent to arterials with high travel speeds (45 mph+)

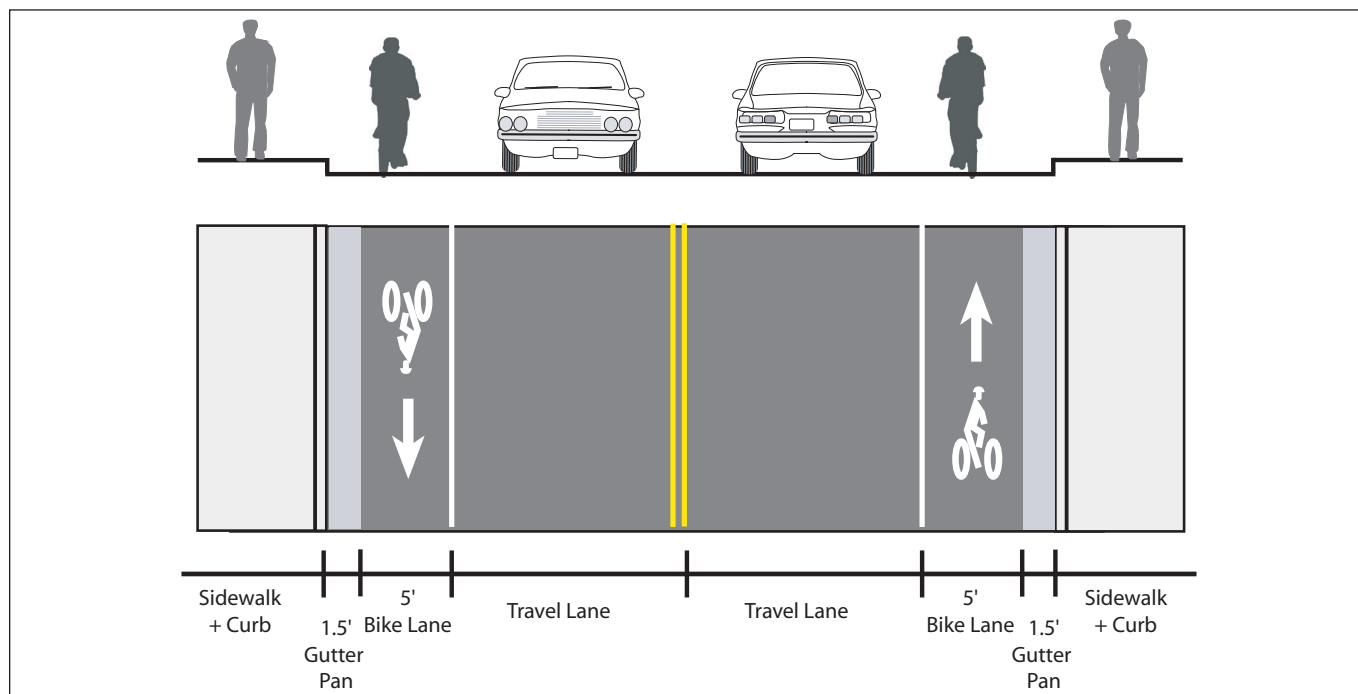
Discussion

Wider bike lanes are desirable in certain circumstances such as on higher speed arterials (45 mph+) where a wider bike lane can increase separation between passing vehicles and cyclists. Wide bike lanes are also appropriate in areas with high bicycle use. A bike lane width of 6 to 8 feet makes it possible for bicyclists to ride side-by-side or pass each other without leaving the bike lane, increasing the capacity of the lane. Appropriate signing and stenciling is important with wide bike lanes to ensure motorists do not mistake the lane for a vehicle lane or parking lane.



Recommended Design

Recommended Design



Two Lane Cross-Section with No Parking (Bike lanes may be 4' in width under constrained circumstances)

5. Bike Facility Design Options

Bike Lanes With Right-Turn Pockets

Design Summary

Bike Lane Width:

- Bike lane should be at least 4' wide (5' preferred)

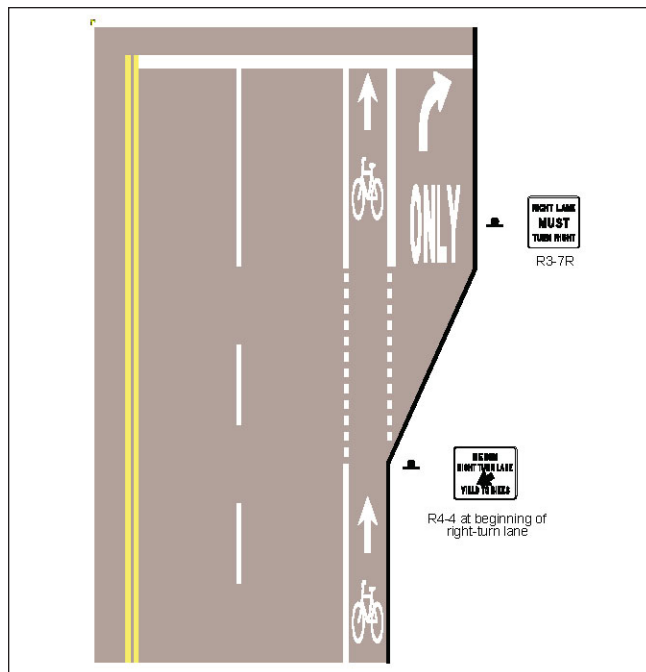
Discussion

The appropriate treatment at right-turn lanes is to place the bike lane between the right-turn lane and the right-most through lane or, where right-of-way is insufficient, to drop the bike lane entirely approaching the right-turn lane. The design (right) illustrates a bike lane pocket, with signage indicating that motorists should yield to bicyclists through the conflict area. While the dashed lines in this area are currently an optional treatment, it is recommended that they be an integral part of any intersection with this treatment in Milwaukee.

Dropping the bike lane is not recommended, and should only be done when a bike lane cannot be accommodated at the intersection.



Continuing a bike lane straight while providing a right-turn pocket reduces bicycle/motor vehicle conflicts



Recommended Design

5. Bike Facility Design Options

Retrofitting Existing Streets with Bike Lanes

Design Summary

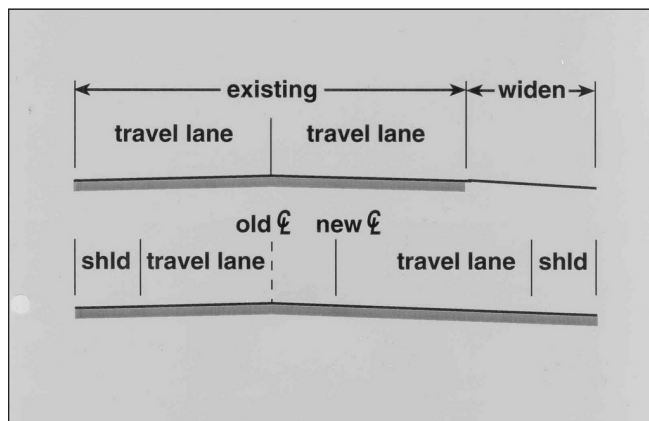
This section describes several strategies for retrofitting bike lanes to existing streets. Treatments include:

- Roadway widening
- Lane narrowing
- Lane reconfiguration
- Parking reduction

Although largely intended for major streets, these measures may be appropriate on some lower-order streets where bike lanes would best accommodate cyclists.

Discussion

Most major streets in Milwaukee are characterized by conditions for which dedicated bike lanes are appropriate to accommodate safe and comfortable riding (e.g., high vehicle speeds and/or volumes). Although opportunities to add bike lanes through roadway widening may exist in some locations, most major streets in Milwaukee pose physical and other constraints requiring street retrofit measures within existing curb-to-curb widths. As a result, many of the recommended measures effectively reallocate existing street width through striping modifications to accommodate dedicated bike lanes.



Design guidance for widening roadway shoulders to accommodate bicycles

Retrofitting Existing Streets with Bike Lanes - Roadway Widening

Design Summary

Bike Lane Width:

- 6' preferred
- 4' minimum (see bike lane guidance)

Discussion

Bike lanes could be accommodated on several streets with excess right-of-way through shoulder widening. Although street widening incurs higher expenses compared with re-striping projects, bike lanes could be added to streets currently lacking curbs, gutters and sidewalks without the high costs of major infrastructure reconstruction.

As a long-term measure, the city of Milwaukee should find opportunities to add bike lanes to other major streets where they are needed. Opportunities include adding bike lanes as streets and bridges are widened for additional auto capacity or as property development necessitates street reconstruction.

Guidance for this treatment comes from the AASHTO Guide for the Development of Bicycle Facilities.



Roadway widening is preferred on roads lacking curbs, gutters and sidewalks

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Retrofitting Existing Streets with Bike Lanes - Lane Narrowing (Road Diet 1)

Design Summary

Vehicle Lane Widths:

- Before: 12'-15'; after: 10'-11'

Bike Lane Width:

- See bike lane design guidance

Discussion

Also called a 'Road Diet', lane narrowing utilizes roadway space that exceeds minimum standards to create the needed space to provide bike lanes. Many Milwaukee roadways have existing lanes that are wider than those prescribed in local and national roadway design standards. Most standards allow for the use of 11-foot and sometimes ten-foot-wide travel lanes to create space for bike lanes. Ten-foot-wide lanes should only be considered on streets with low truck and bus traffic.

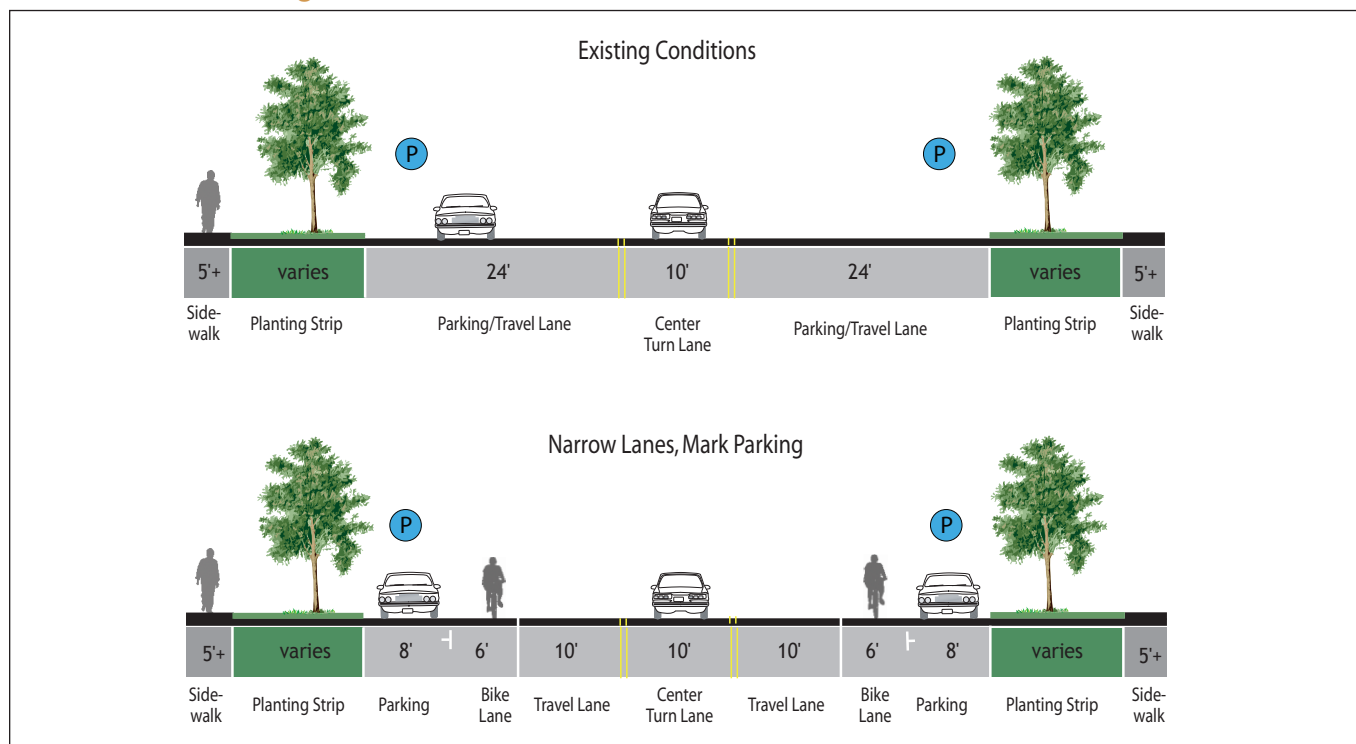
Special consideration should be given to the amount of heavy vehicle traffic and horizontal curvature before the decision is made to narrow travel lanes. Center turn lanes can also be narrowed in some situations to free up pavement space for bike lanes.

Design Example



This street previously had 13' lanes, which were narrowed to accommodate bike lanes without removing a lane

Recommended Design



Example of vehicle travel lane narrowing to accommodate bike lanes

5. Bike Facility Design Options

Retrofitting Existing Streets with Bike Lanes - Lane Reconfiguration (Road Diet 2)

Design Summary

Vehicle Lane Widths:

- Width depends on project. No narrowing may be needed if a lane is removed.

Bike Lane Width:

- See bike lane design guidance

Discussion

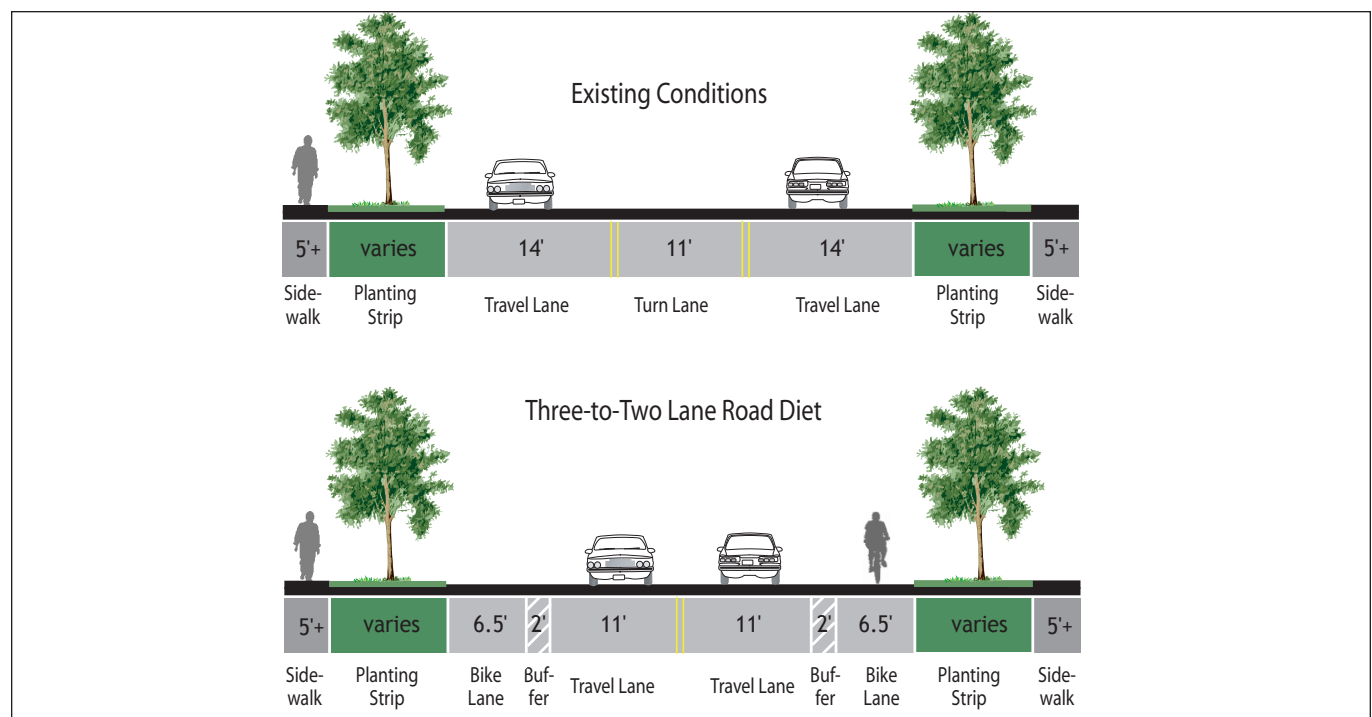
The removal of a single travel lane will generally provide sufficient space for bike lanes on both sides of a street. Streets with excess vehicle capacity provide opportunities for bike lane retrofit projects. Depending on a street's existing configuration, traffic operations, user needs and safety concerns, various lane reduction configurations exist. For instance, a four-lane street (with two travel lanes in each direction) could be modified to include one travel lane in each direction, a center turn lane and bike lanes. Prior to implementing this measure, a traffic analysis should identify impacts.

Recommended Design



This road was re-striped to convert four vehicle travel lanes into three travel lanes with bike lanes. The center lane can also be configured as individual left turn lanes or a median.

Design Example



Example of vehicle travel lane narrowing to accommodate bike lanes

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Retrofitting Existing Streets with Bike Lanes - Parking Reduction (Road Diet 3)

Design Summary

Vehicle Lane Widths:

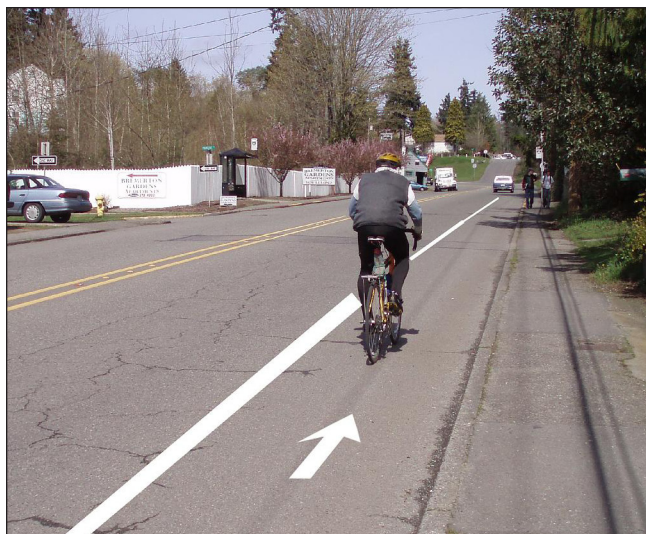
Width depends on project. No narrowing may be needed depending on the width of the parking lane to be removed.

Bike Lane Width:

See bike lane design guidance.

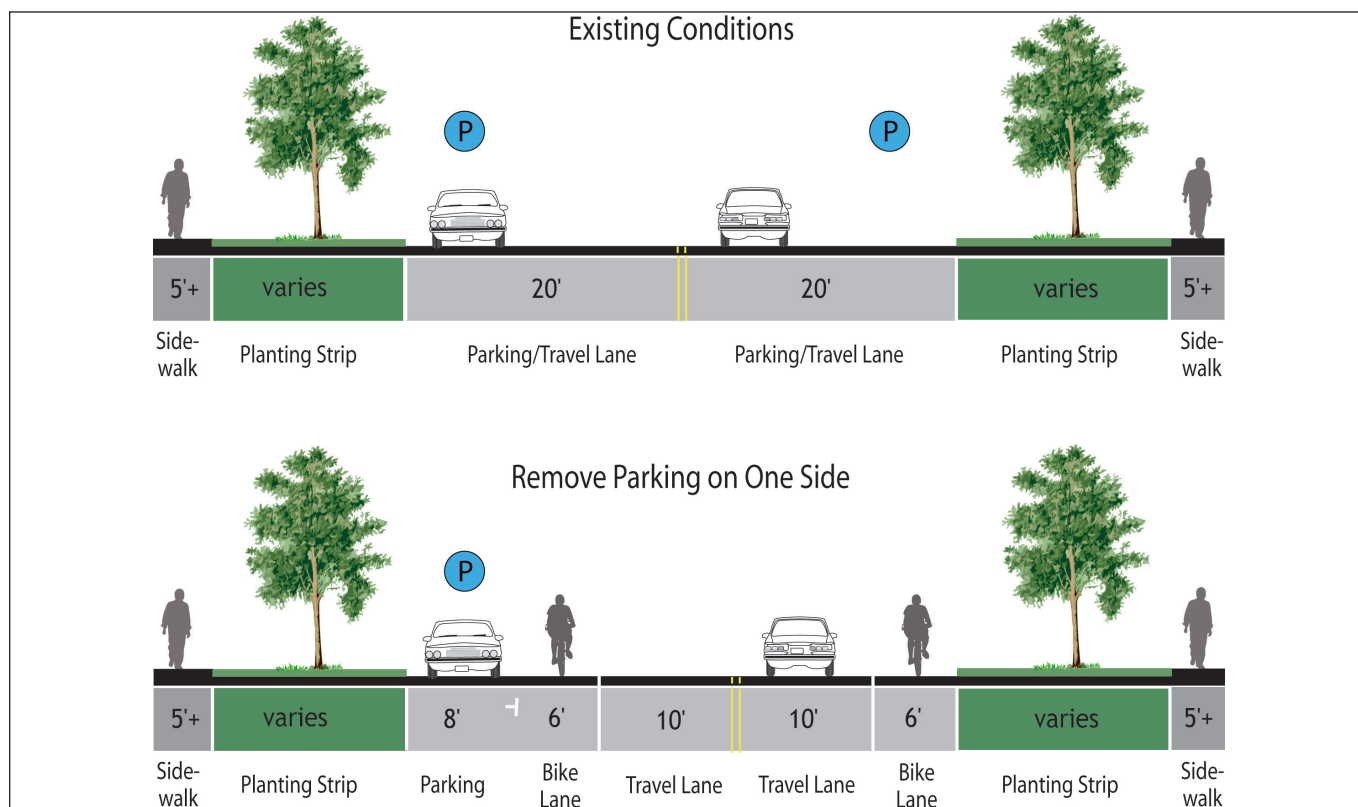
Discussion

Bike lanes could replace one or more on-street parking lanes on streets where excess parking exists and/or the importance of bike lanes outweighs parking needs. For instance, parking may be needed on only one side of a street (as shown below and at right). Eliminating or reducing on-street parking also improves sight distance for cyclists in bike lanes and for motorists on approaching side streets and driveways. Prior to reallocating on-street parking for other uses, a parking study should be performed to gauge demand.



Some streets may not require parking on both sides

Recommended Design



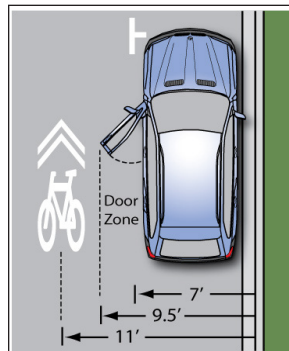
Example of parking removal to accommodate bike lanes

5. Bike Facility Design Options

Shared Lane Markings

Design Summary

Shared-lane markings (also known as “sharrows”) are high-visibility pavement markings that help position bicyclists within the travel lane. These markings are often used on streets where dedicated bike lanes are desirable but are not possible due to physical or other constraints. Sharrows are placed strategically in the travel lane to alert motorists of bicycle traffic, while also encouraging cyclists to ride at an appropriate distance from the “door zone” of adjacent parked cars. Placed in a linear pattern along a corridor (typically every 100-200 feet), sharrows also encourage cyclists to ride in a straight line so their movements are predictable to motorists. These pavement markings have been successfully used in many small and large communities throughout the U.S. Shared-lane markings made of thermoplastic tend to last longer than traditional paint.



Shared lane marking placement guidance with on-street parking

Door Zone Width:

The width of the door zone is generally assumed to be 2.5' from the edge of the parking lane.

Recommended Placement:

- At least 11' from face of curb (or shoulder edge) on streets with on-street parking
- At least 4' from face of curb (or shoulder edge) on streets without on-street parking

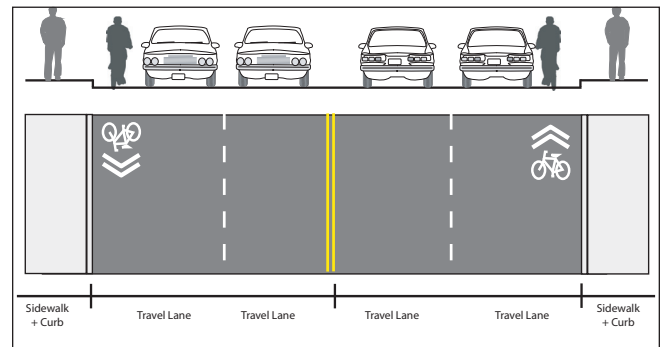
Discussion

The 2009 MUTCD notes that sharrows should not be placed on roadways with a speed limit over 35 MPH, and that, when used, the marking should be placed after an intersection and spaced at intervals no greater than 250' thereafter. Placing shared lane markings between vehicle tire tracks will increase the life of the markings.



Shared lane markings can be used on minor and major roadways

Recommended Design



Recommended Shared Lane Markings

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Shared Roadways/Bicycle Boulevards

Design Summary

Shared roadways are low-volume streets where motorists and bicyclists share the same space. Treatments for shared roadways fall within five “application levels” based on their level of physical intensity, with Level 1 representing the least physically-intensive treatments that could be implemented at relatively low cost. The levels are graphically displayed on page 71. Identifying appropriate application levels for individual shared roadways provides a starting point for selecting appropriate site-specific improvements.

Discussion

Traffic calming and other treatments along the corridor reduce vehicle speeds so that motorists and bicyclists generally travel at the same speed, creating a safer and more-comfortable environment for all users. Shared roadways incorporate treatments to facilitate safe and convenient crossings where bicyclists must traverse major streets. They work best in well-connected street grids where riders can follow reasonably direct and logical routes and when higher-order parallel streets exist to serve thru vehicle traffic.

Additional Guidance

Shared roadways serve a variety of purposes:

- **Parallel major streets lacking bicycle facilities**
Higher-order streets such as arterials and major collectors typically include major bicyclist destinations (e.g., commercial and employment areas). However, these corridors often lack bike lanes or other dedicated facilities thereby creating an uncomfortable, unattractive and potentially unsafe riding environment. Shared roadways serve as alternate parallel facilities allowing cyclists to avoid major streets for longer trip segments.
- **Parallel major streets with bicycle facilities that are uncomfortable for some users**
Some users may not feel comfortable using bike lanes on major streets for various reasons, including high traffic volumes and vehicle speeds, conflicts with motorists entering and leaving driveways, and/or conflicts with buses occupying the bike lane while loading and unloading passengers. Children and less-experienced riders might find these environments especially challenging. Shared roadways provide alternate routes for bicyclists uncomfortable using the major street network. It should be noted that bike lanes on major streets provide important access to key land uses, and the major street network often provides the most direct routes between major destinations. For these reasons, shared roadways should complement a bike lane network and not serve as a substitute.



Shared roadways are low-speed streets that provide a comfortable and pleasant experience for cyclists

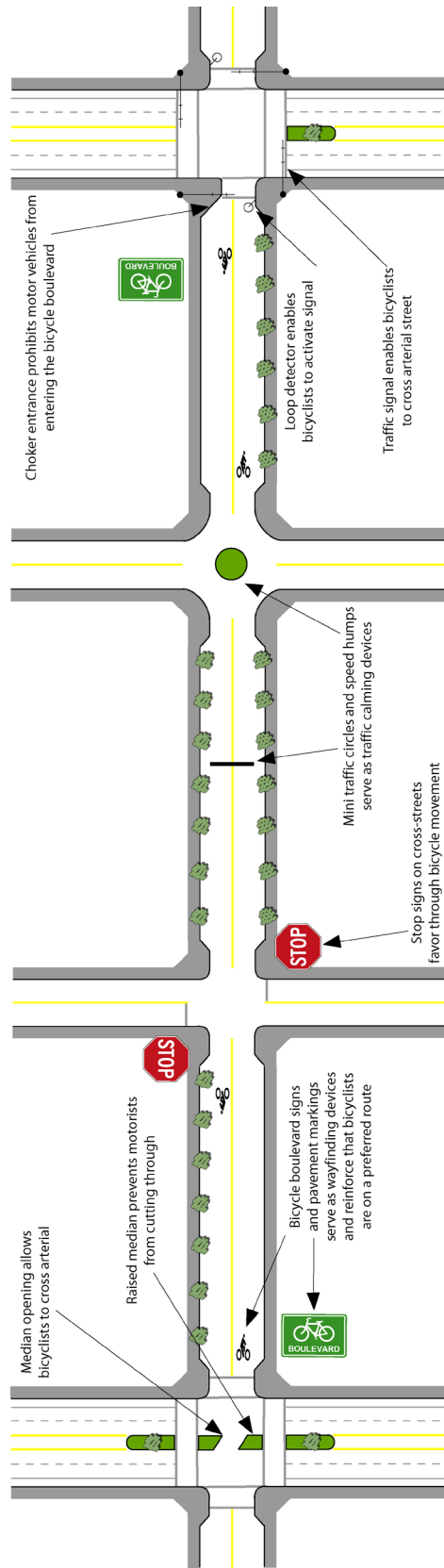
- **Ease of implementation on most local streets**
Shared roadways incorporate cost-effective and less physically-intrusive treatments than bike lanes and cycle tracks. Most streets could be provided relatively inexpensive treatments like new signage, pavement markings, striping and signal improvements to facilitate bicyclists’ mobility and safety. Other potential treatments include curb extensions, medians, and other features that can be implemented at reasonable cost and are compatible with emergency vehicle accessibility.
- **Benefits beyond an improved bicycling environment**
Residents living on shared roadways benefit from reduced vehicle speeds and thru traffic, creating a safer and more attractive environment. Pedestrians can also benefit from boulevard treatments (e.g., by improving the crossing environment where boulevards meet major streets).
- Shared roadways can employ a variety of treatments from simple signage to traffic calming and/or pavement stenciling. The level of treatment depends on several factors, discussed on the following pages.

Sample Shared Roadway/Bicycle Boulevard Treatments

It should be noted that corridors targeted for higher-level applications would also receive relevant lower-level treatments. As shown in the graphic on page 71, a street targeted for Level 3 applications should also include Level 1 and 2 applications, as necessary. It should also be noted that some applications may be appropriate on some streets while inappropriate on others; it may not be appropriate or necessary to implement all “Level 2” applications on a Level 2 street. Furthermore, several treatments could fall within multiple categories as they achieve multiple goals. To identify and develop specific treatments for each bicycle boulevard, the city of Milwaukee should involve the bicycling community and neighborhood groups. Further analysis and engineering work may also be necessary to determine the feasibility of some applications.

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Additional Guidance

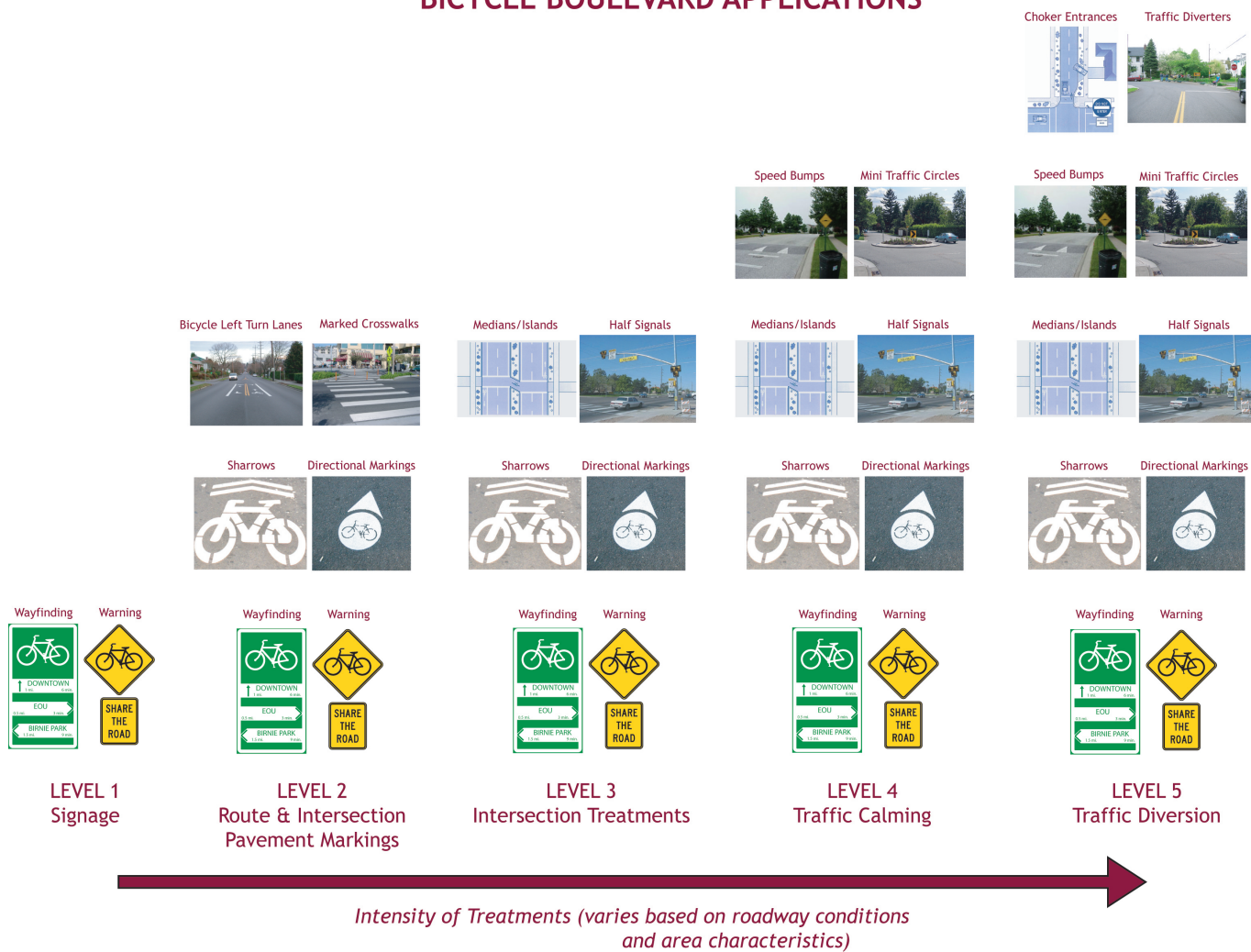


Sample Shared Roadway/Bicycle Boulevard Treatments

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Additional Guidance

BICYCLE BOULEVARD APPLICATIONS



It should be noted that corridors targeted for higher-level applications would also receive relevant lower-level treatments. For instance, a street targeted for Level 3 applications should also include Level 1 and 2 applications, as necessary. It should also be noted that some applications may be appropriate on some streets while inappropriate on others. In other words, it may not be appropriate or necessary to implement all “Level 2” applications on a Level 2 street. Furthermore, several treatments could fall within multiple categories as they achieve multiple goals. To identify and develop specific treatments for each bicycle boulevard, the City of Milwaukee should involve the bicycling community and neighborhood groups. Further analysis and engineering work may also be necessary to determine the feasibility of some applications.

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Level 1: Shared Roadway/Bicycle Boulevard Signing

Design Summary

Signage is a cost-effective, yet highly-visible treatment that can improve the riding environment on a bicycle boulevard network.

Wayfinding Signs

Wayfinding signs are typically placed at key locations leading to and along bicycle boulevards, including where multiple routes intersect and at key bicyclist “decision points.” Wayfinding signs displaying destinations, distances and “riding time” can dispel common misperceptions about time and distance while increasing users’ comfort and accessibility to the boulevard network.



Wayfinding signs help bicyclists stay on designated bicycle routes

Wayfinding signs also visually cue motorists that they are driving along a bicycle route and should correspondingly use caution. Note that too many signs tend to clutter the right-of-way, and it is recommended that these signs be posted at a level most visible to bicyclists and pedestrians, rather than per vehicle signage standards.

Signs should comply with MUTCD approved standards contained in Section 9B.2 of the 2009 document.

Suggested placement guidelines are found in the AASHTO Bike Guide include placing signs every 500 meters along routes, at all turns and at major signalized intersections.

Warning signs

Warning signs advising motorists to “share the road” and “watch for bicyclists” may also improve bicycling conditions on a bicycle boulevard network. These signs are especially useful near major bicycle trip generators such as schools, parks and other activity centers. Warning signs should also be placed on major streets approaching bicycle boulevards to alert motorists of bicyclist crossings.

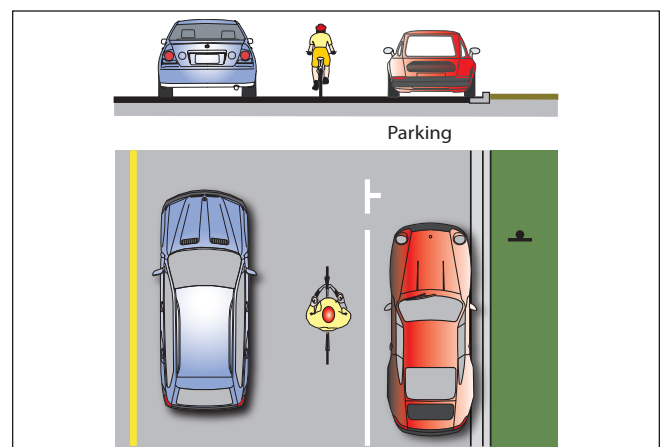


‘Share the Road’ signage can remind both bicyclists and motorists to watch for other vehicles

Level 2: Shared Roadway/Bicycle Boulevard Pavement Markings

On-Street Parking Delineation

Delineating on-street parking spaces with paint or other materials clearly indicates where a vehicle should be parked, and can discourage motorists from parking their vehicles too far into the adjacent travel lane. This helps cyclists by maintaining a wide enough space to safely share a travel lane with moving vehicles while minimizing the need to swerve farther into the travel lane to maneuver around parked cars. In addition to benefiting cyclists, delineated parking spaces also promote the efficient use of on-street parking by maximizing the number of spaces in high-demand areas.



On-Street Parking Delineation

Bicycle Boulevard/ Directional Pavement Markings

Directional pavement markings (also known as “bicycle boulevard markings”) lead cyclists along a Boulevard and reinforce that they are on a designated route. Markings can take a variety of forms.

When a bicycle boulevard follows several streets (with multiple turns at intersections), additional markings accompanied by directional arrows are provided to guide cyclists through turns and other complex routing areas. Directional pavement markings also visually cue motorists that they are traveling along a bicycle route and should exercise caution.



Bicycle boulevard directional marking

5. Bike Facility Design Options

Level 3: Shared Roadway/Bicycle Boulevard Intersection Treatments

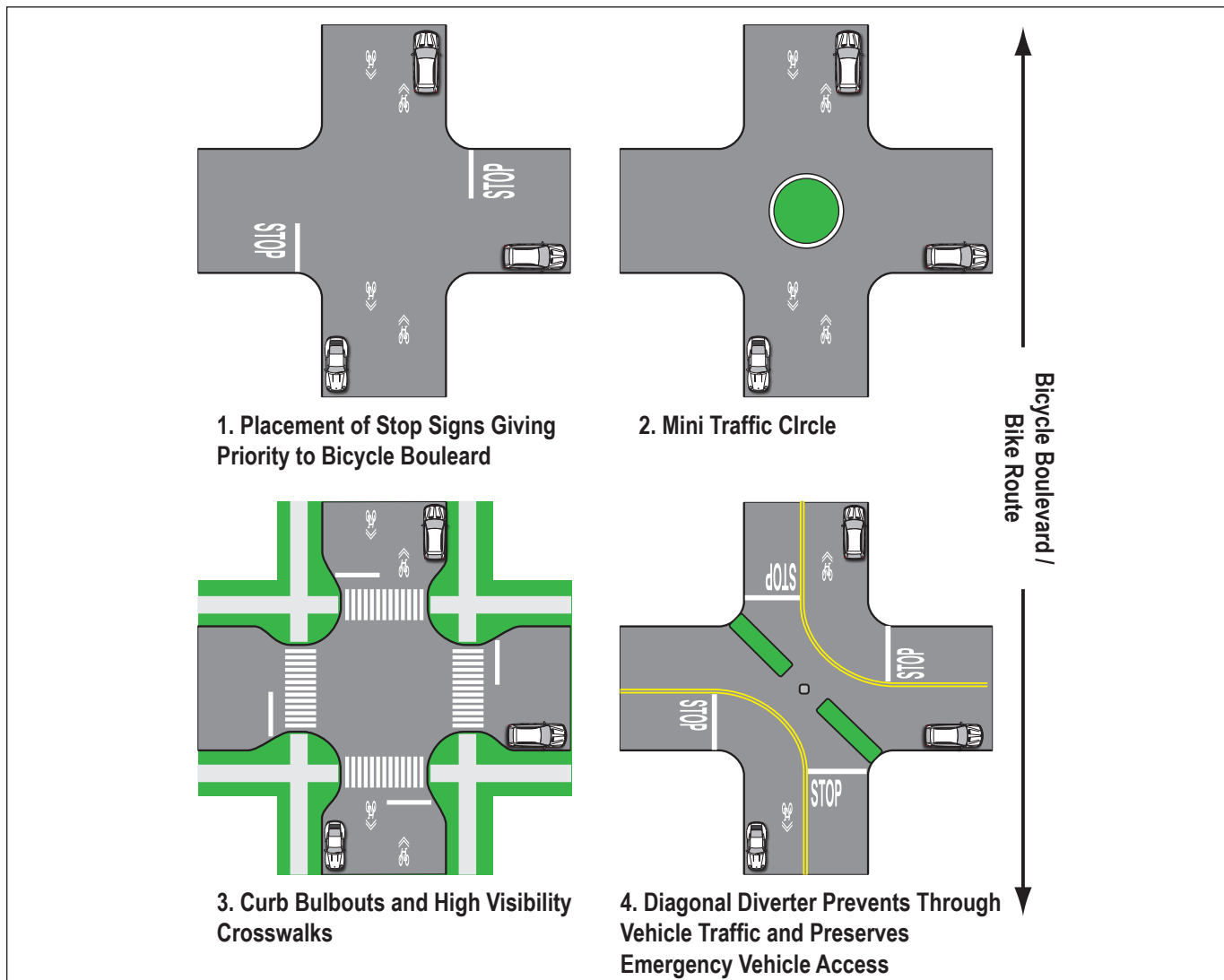
Design Summary

Intersection treatments represent a critical component of Bicycle Boulevards. Intersection traffic controls favoring through bicycle movement on the boulevard facilitate continuous and convenient bicycle travel. Intersection treatments also provide convenient and safe crossings where boulevards intersect major roads. The following sections discuss various intersection improvement tools.

Guidance from: Berkeley Bicycle Boulevard Design Tools and Guidelines, available at: webserver.ci.berkeley.ca.us/uploaded-Files/Public_Works/Level_3_-_General/ch4_.pdf



Intersection treatments are critical to bicyclists' safety on bicycle boulevards



Levels of bicycle boulevard intersection treatments

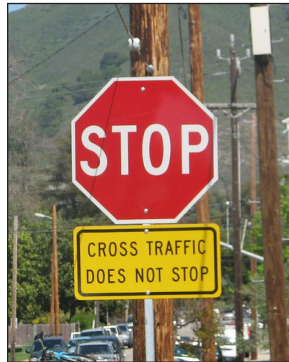
5. Bike Facility Design Options

Stop Sign on Cross-Street

The installation of a stop sign on cross streets along the bicycle boulevard maximizes through bicycle connectivity and momentum and forces motorists crossing the facility to stop and proceed when safe.

This treatment should be used judiciously. It can be combined with traffic-calming efforts to prevent excessive vehicle speeds on the bicycle boulevard.

Stop signs are a relatively inexpensive treatment that is quite effective at minimizing bicycle and cross-vehicle conflicts. However, placing stop signs at all intersections along bicycle boulevards may be an unwarranted traffic control device.



Stop signs effectively minimize conflicts

Neighborhood Traffic Circle

Typically, neighborhood traffic circles are implemented where the bicycle boulevard intersects a local or even a collector street if ADT is less than 2,000. Stop signs may be added on the cross streets if necessary, otherwise all traffic yields at intersections. Signage and striping treatments should be implemented based on expected traffic volumes.



Mini traffic circles require that both bicyclists and motorists slow down and watch for conflicts

For example, the circle itself may be appropriate for local intersections with very low ADT, while increased signage and splitter striping may be appropriate experiencing higher traffic volumes. Neighborhood traffic circles can be landscaped for added visual impact and traffic calming effect. This treatment should be designed with adequate curb radii for emergency vehicle access.

Neighborhood traffic circles are very effective at reducing bicycle and cross vehicle conflicts and add traffic calming in all directions. Mini traffic circles have a moderate cost (approximately \$20,000 per intersection).

Curb Bump-Outs and High-Visibility Crosswalks

This treatment is appropriate for bicycle boulevards near activity centers that may generate large amounts of pedestrian activity such as schools or commercial areas.

The bump-outs should only extend across the parking lane and should not obstruct bicyclists' path of travel or the travel lane. This treatment may be combined with a stop sign on the cross street if necessary.



Curb bump-outs can include street trees

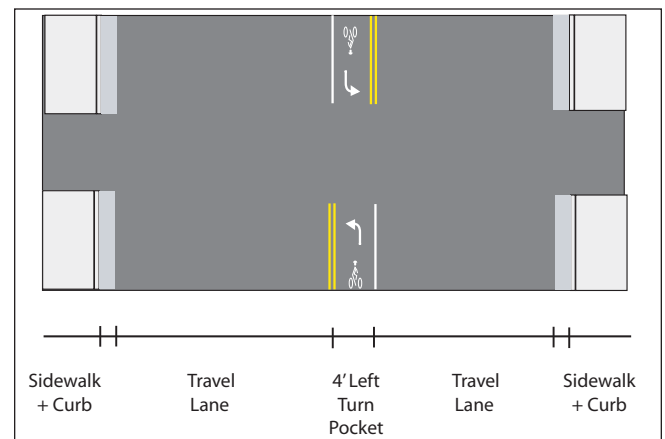
Curb bump-outs and high-visibility crosswalks both calm traffic and also increase the visibility of pedestrians waiting to cross the street. However, they may impact on-street parking.

Bicycle Left-Turn Lane

Bicycle boulevards crossing major streets at offset intersections can incorporate "bicycle left-turn lanes" to facilitate easier bicyclist crossings. Similar to medians/refuge islands, bicycle left-turn lanes allow the crossing to be completed in two phases. A bicyclist on the bicycle boulevard could execute a right-hand turn onto the cross-street, and then wait in a delineated left-turn lane (if necessary to wait for a gap in oncoming traffic). The bike turn pockets should be at least five feet wide, with a total of 11 feet for both turn pockets and center striping.



Example of a bicycle left-turn pocket



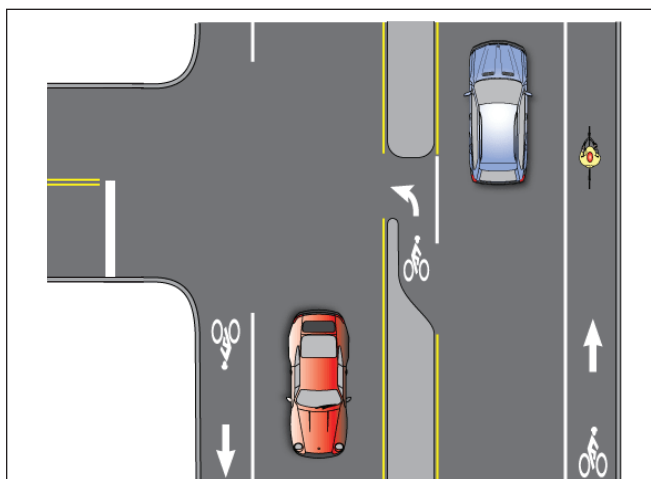
5. Bike Facility Design Options

Bicycle Left Turn Pocket

A bike-only left turn pocket permits bicycle left turn movements while restricting vehicle left turn movements. If the intersection is signal-controlled, the left turn pocket may have a left arrow signal, depending on bicycle and vehicle volumes. Signs should be provided that prohibit motorists from turning, while allowing access to bicyclists. Bicycle signal heads may also be used at busy or complex intersections. Ideally, the left turn pocket should be protected by a raised curb, but the pocket may also be defined by striping if necessary. Because of the restriction on vehicle left turning movements, this treatment also acts as traffic diversion.



This bike-only left-turn pocket guides cyclists along a popular bike route



Bicycle Signal Warrant

A bicycle signal may be considered for use only when the volume and collision or volume and geometric warrants have been met:

- 1. **VOLUME.** When $W = B \times V$ and $W > 50,000$ and $B > 50$. Where W is the volume warrant, B is the number of bicycles at the peak hour entering the intersection, and V is the number of vehicles at the peak hour entering the intersection (same peak hour).



- 2. **COLLISION.** When 2 or more bicycle/vehicle collisions of types susceptible to correction by a bicycle signal have occurred over a 12-month period and the responsible ACHD official determines that a bicycle signal will reduce the number of collisions.
- 3. **GEOMETRIC.** (a) Where a separate bicycle/multi use path intersects a roadway. (b) At other locations to facilitate a bicycle movement that is not permitted for a motor vehicle

This treatment may require experimental status from FHWA.

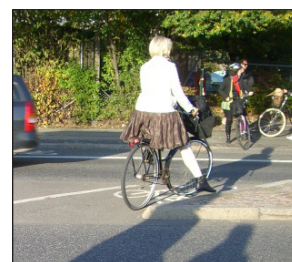
HAWK Signals

In situations where there are few crossable gaps and where vehicles on the major street do not stop for pedestrians and cyclists waiting to cross, HAWK (High-intensity Activated crossWalk) signals could be installed to improve the crossing environment. HAWK signals include pedestrian and bicycle activation buttons and may also include bicycle loop detectors. Many of these models have been used successfully for years overseas, and their use in the U.S. has increased dramatically over the last decade. Current guidance allows the use of HAWK signals only at mid-block crossings and not at intersections. This treatment may require experimental status from FHWA.



Medians/Refuge Islands

At uncontrolled intersections along bicycle boulevards and major streets, a bicycle crossing island can be provided to allow cyclists to cross one direction of traffic at a time when gaps in traffic allow. The bicycle crossing island should be at least 8' wide (measured perpendicular to the centerline of the major road) to be used as the bike refuge area. Narrower medians can accommodate bikes if the holding area is at an acute angle to the major roadway, which allows stopped cyclists to face oncoming motorists. Railings can also be provided so bicyclists do not have to put their feet down, thus making it quicker to start again. Crossing islands can be placed in the middle of the intersection, thus prohibiting left and through vehicle movements.



5. Bike Facility Design Options

Level 4: Shared Roadway/Bicycle Boulevard Traffic Calming

Traffic calming treatments on bicycle boulevards improve the bicycling environment by reducing vehicle speeds to the point where they generally match cyclists' operating speeds, enabling motorists and cyclists to safely co-exist on the same facility. Specific traffic calming treatments are described below.

Chicanes

Chicanes are a series of raised or delineated curb extensions on alternating sides of a street forming an S-shaped curb, which reduce vehicle speeds through narrowed travel lanes (see right). Chicanes can also be achieved by establishing on-street parking on alternate sides of the street. These treatments are most effective on streets with narrower cross-sections.



Mini Traffic Circles

Mini traffic circles are raised or delineated islands placed at intersections, reducing vehicle speeds through tighter turning radii and narrowed vehicle travel lanes (see right). These devices can effectively slow vehicle traffic while facilitating all turning movements at an intersection. Mini traffic circles can also include a paved apron to accommodate the turning radii of larger vehicles, like fire trucks or school buses.



Speed Humps

Shown right, speed humps are rounded raised areas of the pavement that require approaching motor vehicles to reduce speed. These devices also discourage through vehicle travel on a street when a parallel route exists.



Level 5: Shared Roadway/Bicycle Boulevard Traffic Diversion

Traffic diversion treatments maintain through bicycle travel on a street while physically restricting through motor vehicle traffic. These treatments direct through motor vehicle traffic onto parallel higher-order streets while accommodating bicyclists and local vehicle traffic on the bicycle boulevard. Traffic diversion is most effective when higher-order streets can sufficiently accommodate the diverted traffic associated with these treatments.

Choker Entrances

Choker entrances are intersection curb extensions or raised islands allowing full bicycle passage while restricting vehicle access to and from a bicycle boulevard. When they approach a choker entrance at a cross-street, motorists on the bicycle boulevard must turn onto the cross-street while cyclists may continue forward. These devices can be designed to permit some vehicle turning movements from a cross-street onto the bicycle boulevard while restricting other movements.



Traffic Diverters

Similar to choker entrances, traffic diverters are raised features directing vehicle traffic off the bicycle boulevard while permitting through travel.

Advantages:

- Provides safe refuge in the median of the major street so that bicyclists only have to cross one direction of traffic at a time; works well with signal-controlled traffic platoons coming from opposite directions
- Provides traffic calming and safety benefits by preventing left turns and/or through traffic from using the intersection

Disadvantages:

- Potential adverse impacts to motor vehicles along major roadways include lane narrowing, loss of some on-street parking and restricted turning movements
- Crossing island may be difficult to maintain and may collect debris



5. Bike Facility Design Options

Bicycle Parking

Design Summary

Bicycle parking can be broadly defined as either short-term or long-term parking:

- Short-term parking: parking meant to accommodate visitors, customers, messengers and others expected to depart within two hours; requires approved standard rack, appropriate location and placement, and weather protection.
- Long-term parking: parking meant to accommodate employees, students, residents, commuters and others expected to park more than two hours. This parking is to be provided in a secure, weather-protected manner and location.

Short-Term Parking

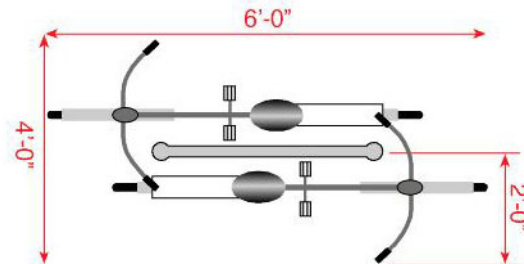
Short-term bicycle parking facilities include racks which permit the locking of the bicycle frame and at least one wheel to the rack, and support the bicycle in a stable position without damage to wheels, frame or components. Short-term bicycle

parking is currently provided at no charge at various locations in Milwaukee. Such facilities should continue to be free, as they provide minimal security, but encourage cycling and promote proper bicycle parking.



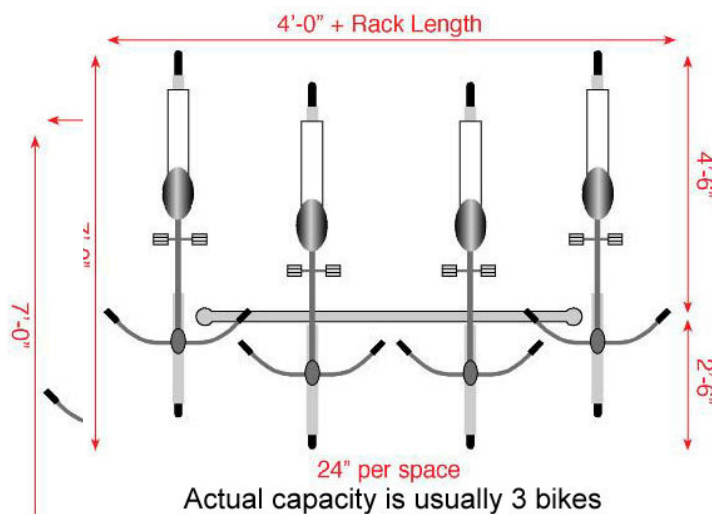
Standard bicycle rack

Hitching Post or Staple Racks



Ribbon, Spiral, or Freestanding Racks

(with access from only one side)



5. Bike Facility Design Options

Bicycle Rack Placement Guidelines

Design Issue	Recommended Guidance
Minimum Rack Height	To increase visibility to pedestrians, racks should have a minimum height of 33 inches or be indicated or cordoned off by visible markers.
Signing	Where bicycle parking areas are not clearly visible to approaching cyclists, signs at least 12 inches square should direct them to the facility. The sign should include the name, phone number, and location of the person in charge of the facility, where applicable.
Lighting	Lighting of not less than one foot-candle illumination at ground level should be provided in all bicycle parking areas.
Frequency of Racks on Streets	In popular retail areas, two or more racks should be installed on each side of each block. This does not eliminate the inclusion of requests from the public which do not fall in these areas. Areas officially designated or used as bicycle routes may warrant the consideration of more racks.
Location and Access	Access to facilities should be convenient. Where access is by sidewalk or walkway, ADA-compliant curb ramps should be provided where appropriate. Parking facilities intended for employees should be located near the employee entrance, and those for customers or visitors near main public entrances. Convenience should be balanced against the need for security if the employee entrance is not in a well traveled area. Bicycle parking should be clustered in lots not to exceed 16 spaces each. Large expanses of bicycle parking make it easier for thieves to be undetected.
Locations within Buildings	Provide bike racks within 50 feet of the entrance. Where a security guard is present, provide racks behind or within view of a security guard. The location should be outside the normal flow of pedestrian traffic.
Locations near Transit Stops	To prevent bicyclists from locking bikes to bus stop poles - which can create access problems for transit users, particularly those who are disabled - racks should be placed in close proximity to transit stops where there is a demand for short-term bike parking.
Locations within a Campus-Type Setting	Racks are useful in a campus-type setting at locations where the user is likely to spend less than two hours, such as classroom buildings. Racks should be located near the entrance to each building. Where racks are clustered in a single location, they should be surrounded by a fence and watched by an attendant. The attendant can often share this duty with other duties to reduce or eliminate the cost of labor being applied to bike parking duties; a cheaper alternative to an attendant may be to site the fenced bicycle compound in a highly visible location on the campus. For long-term parking needs of employees and students, attendant parking and/or bike lockers are recommended.
Retrofit Program	In established locations, such as schools, employment centers, and shopping centers, the city should conduct bicycle audits to assess bicycle parking availability and access, and add additional bicycle racks where necessary.

On-Street Parking

Where the placement of racks on sidewalks is not possible (e.g., due to narrow sidewalk width, sidewalk obstructions or other issues), bicycle parking can be provided in the street where on-street vehicle parking is allowed. Two possible options for creating parking in the street include clustered racks in a vehicle parking space protected by bollards or curbs, and racks installed on sidewalk curb extensions where adequate sight distance exists. Installing bicycle parking directly in a car parking space incurs only the cost of the racks and bollards or other protective devices.

While on-street bicycle parking may take space away from the automobile parking, additional auto parking spaces can be created by consolidating driveways, moving fire hydrants, or otherwise finding places where it may be possible to permit auto parking where it is currently prohibited. Options for combining bicycle and motorcycle parking also exist.



On-street bicycle parking may be installed at intersection corners or at mid-block locations

5. Bike Facility Design Options

Bikeway Maintenance

This section presents guidelines for incorporating bicycle facilities into construction, maintenance and repair activities. The guidelines are presented as a menu of options for maintenance activities, and not strict guidelines.

Street Construction and Repair

Safety of all roadway users should be considered during road construction and repair. Wherever bicycles are allowed, measures should be taken to provide for the continuity of a bicyclist's trip through a work zone area. Only in rare cases should pedestrians and bicyclists be detoured to another street when travel vehicle lanes remain open. The following actions are recommended:

- Bicyclists should not be led into conflicts with work site vehicles, equipment, moving vehicles, open trenches or temporary construction signage.
- Efforts should be made to re-create the bike lane (if one exists) to the left of the construction zone if space exists to do so safely.
- Where there is insufficient space to provide a bike lane adjacent to the construction zone, then a standard wide travel lane should be considered. If steel plating is used, special care should be taken to ensure that bicyclists can traverse the plates safely.
- Contractors performing work for Milwaukee should be made aware of the needs of bicyclists and be properly trained in how to safely route bicyclists through or around work zones.

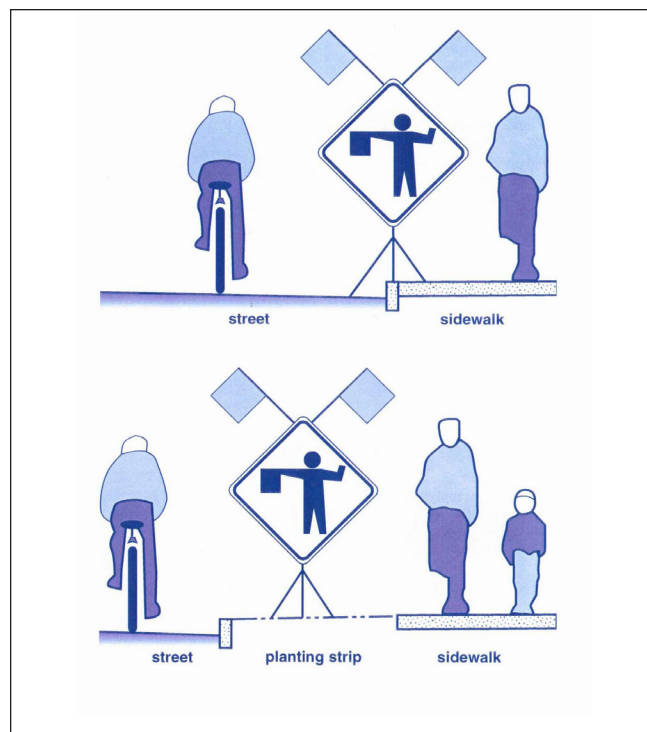
Signage Actions:

Signage related to construction activities should be placed in a location that does not obstruct the path of bicyclists or pedestrians, including bike lanes, wide curb lanes, or sidewalks. In areas where there are grades, signs may be placed at the street-side edge of sidewalks so as not to encroach onto a bike lane.

Detour and closure signage related to bicycle travel may be included on all bikeways where construction activities occur. Signage should also be provided on all other roadways.

The following MUTCD signs should be used:

- W21-4A: Road Work Ahead
- W20-5: Right Lane Closed
- W4-2: Lane Shift, Left Sign
- W11-1: Bicycle Warning Sign
- W16-1: Share The Road



Open Trenches

Plates used to cover trenches are typically not flush with the pavement and have a 1"-2" vertical transition on the edges. This can puncture a hole in a narrow bicycle tire and cause a cyclist to lose control due to the vertical transition. Bicyclists often are left to their own devices to merge with vehicles in the adjacent travel lane.

Although a common practice is to use steel plates during non-construction hours, these plates can be dangerously slippery, particularly when wet.

The city of Milwaukee should consider:

- Ensuring that steel plates do not have a vertical edge greater than 1/4" without an asphalt lip
- Using non-skid steel plates with no raised steel bar
- Requiring temporary asphalt (cold mix) around plates to create a smooth transition and hold the plates in place
- Using steel plates only as a temporary measure during construction, not for extended periods

Like all roadways, bicycle facilities require regular maintenance. This includes sweeping, maintaining a smooth roadway, ensuring that the gutter-to-pavement transition remains relatively flat, and installing bicycle-friendly drainage grates. Pavement overlays should be used as a good opportunity to improve bicycle facilities. The following recommendations are provided as a menu of options for Milwaukee to consider as it augments and enhances its maintenance capabilities.

5. Bike Facility Design Options

Many of the recommendations listed below are already part of Milwaukee's regular maintenance activities.

Recommended Walkway and Bikeway Maintenance Activities

Maintenance Activity	Frequency
Inspections	Seasonal – at beginning and end of Summer
Pavement sweeping/blowing	As needed, weekly in Fall
Pavement sealing, potholes	5 - 15 years
Culvert and drainage grate inspection	Before Winter and after major storms
Pavement markings replacement	1 – 3 years
Signage replacement	1 – 3 years
Shoulder plant trimming (weeds, trees, brambles)	Twice a year; middle of growing season and early Fall
Tree and shrub plantings, trimming	1 – 3 years
Major damage response (washouts, fallen trees, flooding)	As soon as possible

Sweeping

Bicyclists often avoid shoulders and bike lanes filled with sanding materials, gravel, broken glass and other debris. They will ride in the roadway to avoid these hazards, causing conflicts with motorists. Debris from the roadway should not be swept onto sidewalks (pedestrians need a clean walking surface), nor should debris be swept from the sidewalk onto the roadway. A regularly scheduled inspection and maintenance program helps ensure that roadway debris is regularly picked up or swept.

Action items involving sweeping activities include:

- Establishing a seasonal sweeping schedule that prioritizes roadways with major bicycle routes
- Sweeping walkways and bikeways whenever there is an accumulation of debris on the facility
- Sweepers picking up debris in curbed sections; on open shoulders, debris can be swept onto gravel shoulders
- Paving gravel driveway approaches to minimize loose gravel on paved roadway shoulders
- Providing extra sweeping in the fall in areas where leaves accumulate

Roadway Surface

Roadway surface quality is a critical issue for bicyclists. Bicycles are much more sensitive to subtle changes in roadway surface than are motor vehicles. Various materials are used to pave roadways, and some are smoother than others. Compaction is also an important issue after trenches and other construction holes are filled. Uneven settlement after trenching can affect the roadway surface nearest the curb where bicycles travel. Sometimes compaction is not achieved to a satisfactory level, and an uneven pavement surface can result due to settling over the course of days or weeks.

Recommended action items involving maintaining the roadway surface include:

- On all bikeways, use the smallest possible chip for chip sealing bike lanes and shoulders
- Ensure that on new roadway construction, the finished surface on bikeways does not vary more than ¼"
- Maintain a smooth surface of all bikeways
- Maintain pavement so ridge buildup does not occur at the gutter-to-pavement transition or adjacent to railway crossings
- Inspect the pavement 2 to 4 months after trenching construction activities are completed to ensure that excessive settlement has not occurred

Gutter-to-Pavement Transition

On streets with concrete curbs and gutters, 1'-2' of the curb-side area is typically devoted to the gutter pan, where water collects and drains into catch basins. On many streets, the bikeway is situated near the transition between the gutter pan and the pavement edge. At this location water can erode the transition, creating potholes and a rough surface.

The pavement on many streets is not flush with the gutter, creating a vertical transition between these segments. This area can buckle over time, creating a hazardous environment for bicyclists. Since it is the most likely place for bicyclists to ride, this issue is significant for bike travel.

Action items related to maintaining a smooth gutter-to-pavement transition include:

- Ensure that gutter-to-pavement transitions have no more than a ¼" vertical transition
- Examine pavement transitions during every roadway project for new construction, maintenance activities, and construction project activities that occur in streets

5. Bike Facility Design Options

Drainage Grates

Drainage grates are typically located in the gutter area near the curb of a roadway. Drainage grates typically have slots through which water drains into the municipal wastewater system. Many grates are designed with linear parallel bars spread wide enough for a tire to become caught so that if a bicycle were to ride on them, the front tire would become caught and fall through the slot. This would cause the cyclist to tumble over the handlebars and sustain potentially injuries.

The city of Milwaukee should consider the following:

- Require all new drainage grates be bicycle-friendly, including grates that have horizontal slats on them so that bicycle tires do not fall through the vertical slats
- Create a program to inventory all existing drainage grates, and replace hazardous grates as necessary

Pavement Overlays

Pavement overlays represent good opportunities to improve conditions for cyclists if done carefully. A ridge should not be left in the area where cyclists ride (this occurs where an overlay extends part-way into a shoulder bikeway or bike lane). Overlay projects offer opportunities to widen a roadway, or to re-stripe a roadway with bike lanes.

Action items include the following:

- Extend the overlay over the entire roadway surface to avoid leaving an abrupt edge
- If there is adequate shoulder or bike lane width, it may be appropriate to stop at the shoulder or bike lane stripe, provided no abrupt ridge remains
- Ensure that inlet grates, manhole and valve covers are within ¼ inch of the pavement surface
- Pave gravel driveways to property line to prevent gravel from spilling onto shoulders or bike lanes

Signage

Bike lanes, shared shoulders, bicycle boulevards and paths all have different signage types for wayfinding and regulations. Such signage is vulnerable to vandalism or wear, and requires regular maintenance and replacement as needed.

The city of Milwaukee should consider the following:

- Check regulatory and wayfinding signage placed along bikeways for signs of vandalism, graffiti, or normal wear
- Replace signage along bikeways as needed
- Perform a regularly-scheduled check on the status of signage with follow-up as necessary
- Create a maintenance management plan

Landscaping

Bikeways can be rendered inaccessible due to overgrown vegetation. To prevent this, shoulder plants should be trimmed twice a year. Similarly, after a flood or major storm, bikeways should be checked and fallen trees or debris should be removed promptly.

Action items related to landscaping maintenance include:

- Ensure that shoulder plants do not hang into or impede passage along bikeways
- After major damage incidents, remove fallen trees or other debris from bikeways as quickly as possible

Maintenance Management Plan

Bikeway users require accommodation when segments of bikeways are closed or unavailable. Users must be warned of impending bikeway closures and given adequate detour information to bypass the section. Users should be warned through the use of standard signing when approaching each affected section including information on alternate routes and dates of closure. Alternate routes should provide a reasonable level of directness and equivalent traffic characteristics.

Action items include:

- Provide fire and police departments with map of system, along with access points to gates/bollards
- Enforce speed limits and other rules of the road
- Enforce all trespassing laws for people attempting to enter adjacent private properties

5. Bike Facility Design Options

Bikeway Wayfinding Signage

Design Summary

Costing about \$250 each, wayfinding signs are a relatively cost-effective means for improving the walking and bicycling environment.

Discussion

The ability to navigate through a city is informed by landmarks, natural features and other visual cues. Placing signs throughout the city indicating to bicyclists their direction of travel, location of destinations and the riding time/distance to those destinations will increase users' comfort and accessibility to the bicycle system. Wayfinding signs also visually cue motorists that they are driving along a bicycle route and should use caution. Signs are typically placed at key locations leading to and along bicycle routes, including the intersection of multiple routes. Too many road signs tend to clutter the right-of-way, and it is recommended that these signs be posted at a level most visible to bicyclists and pedestrians, rather than per vehicle signage standards. Sign design standards are found in Section 9.2B of the 2009 MUTCD. Placement guidance from AASHTO suggests placing signs approximately every 500M, as well as at all turns and major signalized intersection. MUTCD provides guidance on sign height, placement and setback. Specific jurisdictional guidance (e.g., county and state) should be consulted to ensure that all relevant standards are met.

Signage can serve both wayfinding and safety purposes including:

- Helping to familiarize users with the bikeway system
- Helping users identify the best routes to destinations
- Helping to address misperceptions about time and distance
- Helping overcome a "barrier to entry" for people who do not bicycle often (e.g., "interested but concerned" cyclists)

A community-wide bicycle wayfinding signage plan would identify:

- Sign locations along existing and planned bicycle routes
- Sign type – what information should be included and design features
- Destinations to be highlighted on each sign – key destinations for bicyclists
- Approximate distance and riding time to each destination



Non-Standard Design Treatments

Standard bicycle facility treatments do not always fit within the context of the existing built environment. Narrow rights-of-way, off angled intersections, and unique roadway geometry may necessitate the use of context sensitive, non-standard treatments. These treatments are recommended for consideration and possible use by the city. Many of these treatments cover specific situations intended to create safer travel conditions for cyclists, pedestrians and motorists alike. Non-standard treatments can be used when standard bicycle facility treatments do not fit the context of the existing built environment (e.g., narrow rights-of-way or off-angled intersections). See Appendix M for guidance on FHWA experimental status that may be required for these applications.

5. Bike Facility Design Options

Wide Bicycle Lane Next to On-Street Parallel Parking

Design Summary

Bicycle Lane Width:

7' maximum (may encourage vehicle loading in bicycle lane)

Discussion

Wide bike lanes can be used in areas with significant amounts of bicycle traffic to increase capacity

Wide bike lanes can increase the safety of the facility

Wide bicycle lanes may encourage the bicyclist to ride farther to the right (door zone) to maximize distance from passing traffic

Wide bicycle lanes may also encourage vehicles to use the bicycle lane as a loading zone in busy areas where on-street parking is typically full

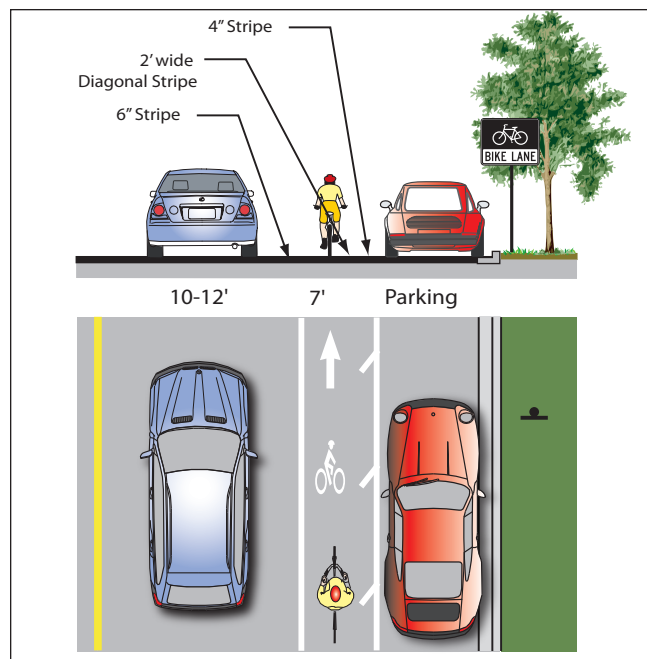
Installing smaller bicycle lane stencils placed to the left of are one way to increase separation

Diagonal stripes can be added to encourage the bicyclist to ride to the left of the bicycle lane to reduce proximity to the door zone

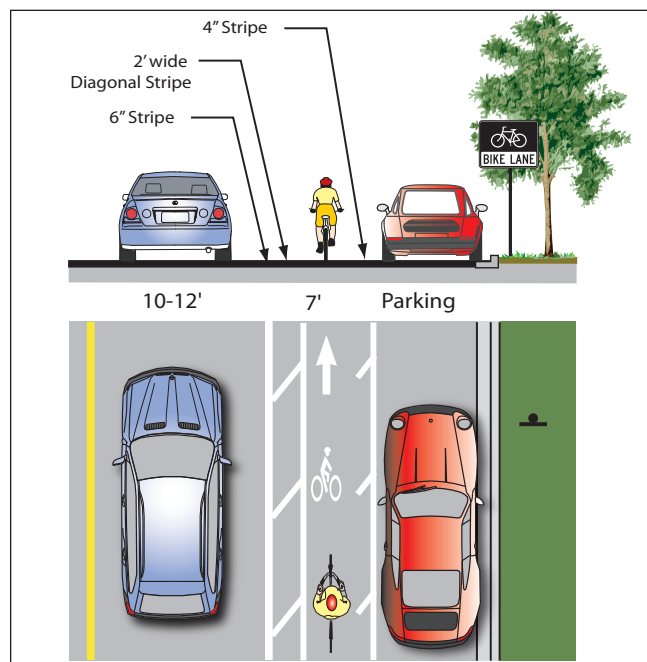
Alternative design 1 places striping between the bicycle and motor vehicle travel lane, visually narrows the vehicle travel lane and creates additional buffer space between slower moving bicycles and faster moving motor vehicles. This design may be problematic on streets with high parking turnover, particularly when cyclist volumes are also high. Motorists will block the bike lane during parking maneuvers and may use the wide bicycle lane as a temporary parking spot while waiting to pull into a legal curbside spot. Safety benefits gained from diagonal striping near parked vehicles (Minimum Design) may be lost. A modified option would add a small diagonal buffer alongside parked cars to encourage cyclists to travel further away from the door zone

Guidance

This treatment is not currently present in any state or federal design standards.



Minimum Design



Alternative Design 1

5. Bike Facility Design Options

Bicycle Lane Next to On-Street Diagonal Parking

Design Summary

Bicycle Lane Width: 5' minimum

White 4-inch stripe separates bicycle lane from parking bays.

Parking bays are sufficiently long to accommodate most vehicles (vehicles do not block bicycle lane)

Discussion

In certain areas, diagonal parking can be used to increase parking supply

Conventional diagonal parking is not compatible or recommended in conjunction with high levels of bicycle traffic

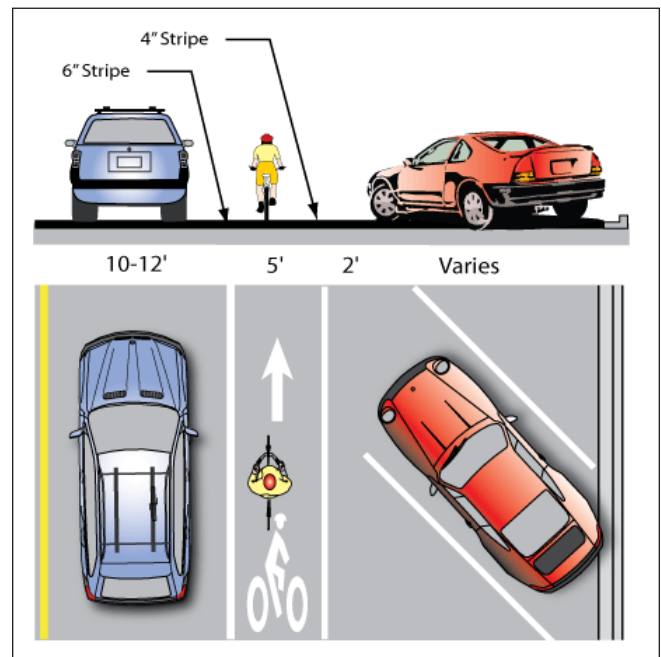
The use of 'back-in diagonal parking' or 'reverse angled parking' is recommended over head-in diagonal parking. This design addresses improves sight distance between drivers and bicyclists and has been shown to reduce parking related crashes

While there may be a learning curve for some drivers, using back-in diagonal parking is typically an easier maneuver than conventional parallel parking

Guidance

This treatment is not currently present in federal design standards but recommended in some states including Oregon.

Design Example



Recommended Design

5. Bike Facility Design Options

Bicycle Boulevard

Design Summary

Signed shared bikeways can be implemented at two levels of treatments depending on the roadway characteristics. Higher level (more intensive) treatments fall into the bicycle boulevard category. Bike Boulevards create on-street travel conditions for cyclists that do not wish to ride in bicycle lanes or may not feel comfortable on streets with heavy motor vehicle traffic.

Discussion

Bike boulevards are ideal for streets with relatively low traffic volumes and posted speeds that enable cyclists and motorists to share the same travel lanes.

Treatment Summary

Level 1 – Signage (e.g., wayfinding and warning)

Level 2 – Pavement Markings (e.g., Wayfinding and Warning)

Level 3 – Intersection Treatments (e.g., turned stop signs and curb extensions)

Level 4 – Traffic Calming (e.g., speed humps)

Level 5 – Traffic Diversion (e.g., choker entrances)

Guidance

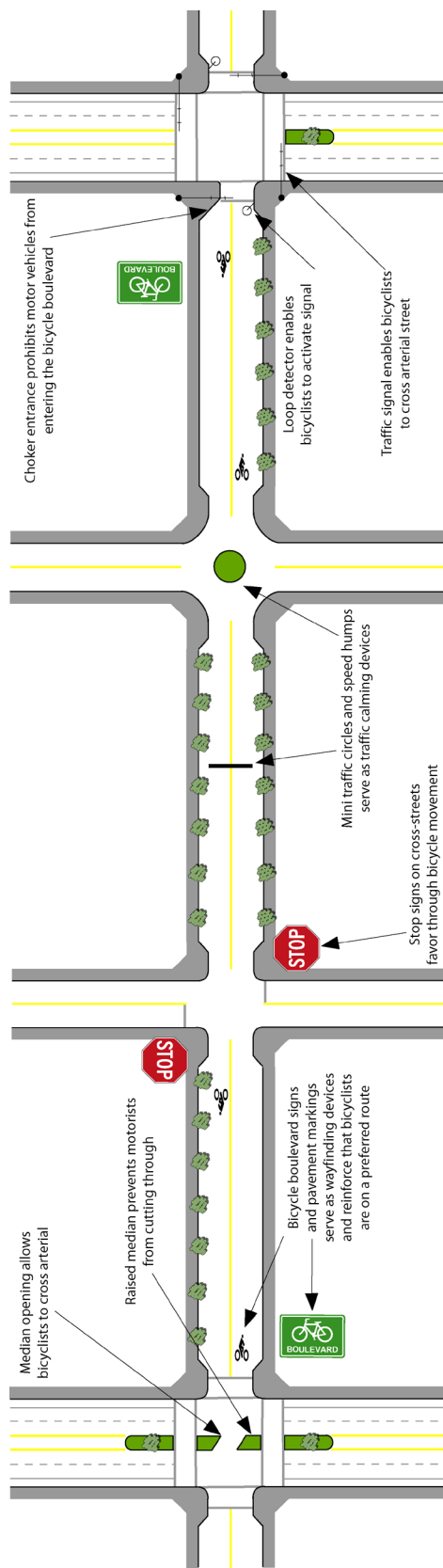
There is no currently adopted federal or state guidance for this treatment though signage and traffic calming (the two key components of Bike Boulevards are discussed in the Wisconsin Bicycle Facility Design Handbook). This treatment will probably not require experimentation permission from FHWA. Treatments are generally site specific.

Previously Implemented in

Portland, OR

Vancouver, B.C.

Berkeley, CA



5. Bike Facility Design Options

Bicycle Lanes at Double Right-Turn Intersections

Design Summary

Width: Minimum width of 4' with 5' preferred.

Discussion

Option A provides a bike lane to the left of the outside turn lane. The design positions bicyclists to the outside of a double right-turn lane

Option B uses shared lane markings in the through/right-turn lane properly positioning through bicyclists and reducing conflicts with right turning vehicles

This treatment should only be considered at locations where the right most turn lane is a pocket at the intersection

Under no circumstances should the bicyclist be expected to merge across two lanes of traffic to continue straight though an intersection

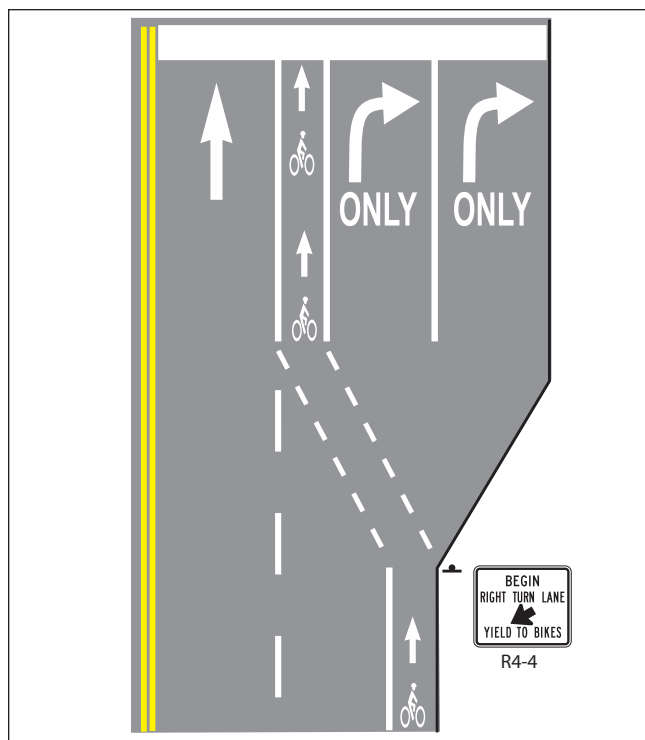
This treatment can be done in both double right-turn lane configurations and in a right/through lane

Double right-turn lanes or an inside through/right combination lane should be avoided on routes with heavy bicycle use

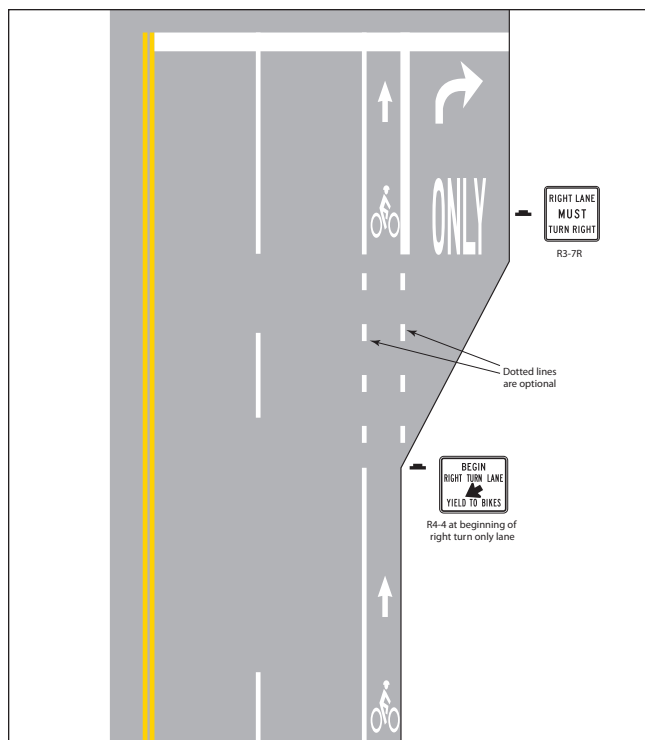
Design Example

Guidance

There is no currently adopted federal or state guidance for this treatment.



Option A 'Bicycle Lane'



Option B 'Shared Lane Marking'

5. Bike Facility Design Options

Bicycle Lanes at Interchanges

Design Summary

Recommended Design

Bicycle Lane Width: 5' minimum and 7' maximum.

Discussion

Dashed bicycle lane lines with or without colored bicycle lanes may be applied to provide increased visibility for bicycles in the merging area.

The benefits of this treatment are similar to those described in the discussion of colored bike lanes in conflict areas.

Design Example

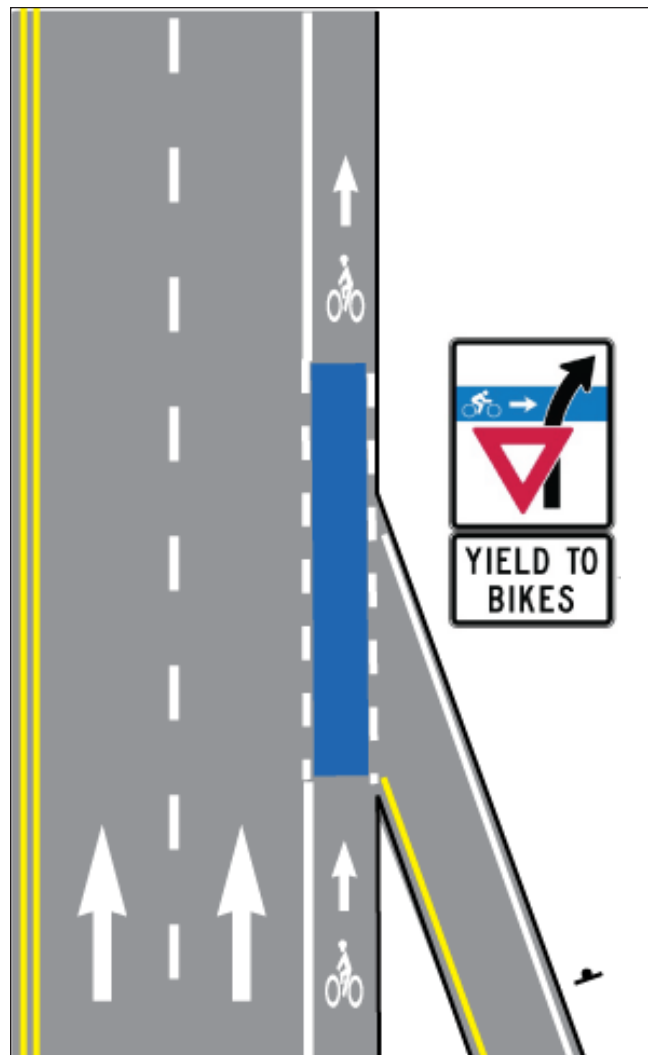


Broadway Bridge at Interstate Avenue in Portland, Oregon. Images provided by Google StreetView and Portland's Blue Bicycle Lanes.

Guidance

This treatment is not currently present in any state or federal design standards.

Portland's Blue Bicycle Lanes: <http://www.portlandonline.com/shared/cfm/image.cfm?id=58842>



Recommended Design

5. Bike Facility Design Options

Colored Bicycle Lanes

Design Summary

Bicycle Lane Width: 5' minimum and 7' maximum.

Discussion

A contrasting color for the paving of bicycle lanes can be applied to continuous sections of roadways

These situations help to better define road space dedicated to bicyclists and make the roadway appear narrower to drivers resulting in beneficial speed reductions

Colored bicycle lanes require additional cost to install and maintain. Techniques include:

Paint – less durable and can be slippery when wet

Colored pavement – colored medium in pavement during construction – most durable

Colored and textured sheets of acrylic epoxy coating

Design Example

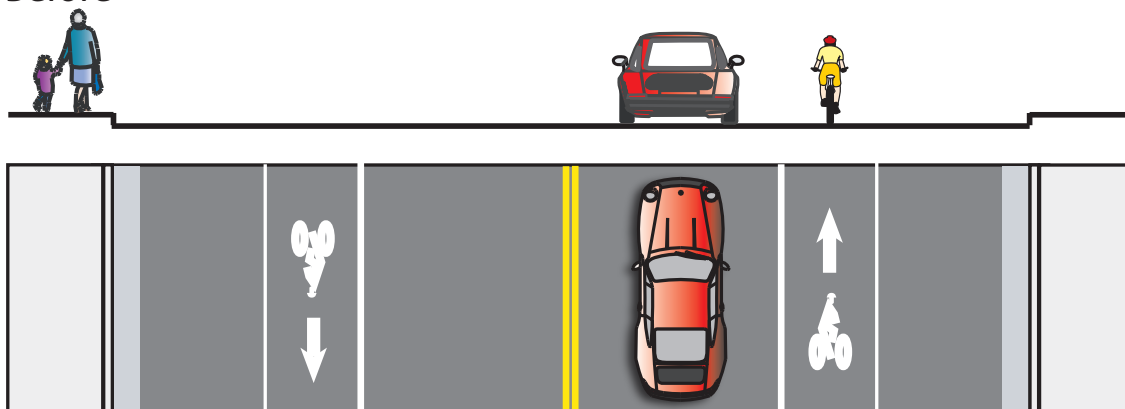


Guidance

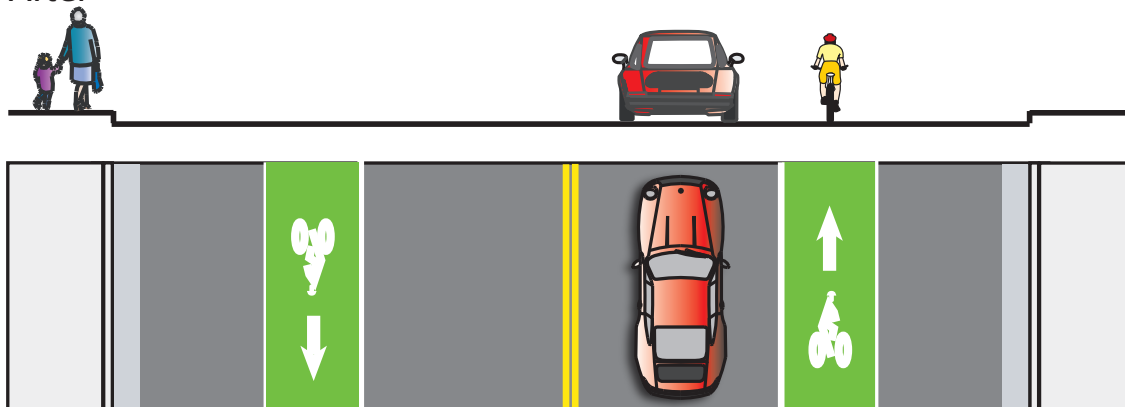
This treatment is not currently present in any state or federal design standards.

Recommended Design

Before



After



5. Bike Facility Design Options

Bicycle Box

Design Summary

A bicycle box is a right angle extension to a bicycle lane at the head of a signalized intersection

Bicycle Box Dimensions:

The bicycle box should be 14' deep to allow for bicycle positioning.

Signage:

Appropriate signage as recommended by the MUTCD applies. Signage should be present to prevent 'right-turn on red' (if applicable) and to indicate where the motorist must stop.

Discussion

Bicycle boxes help reduce risk of "right hook" conflicts between motorists and bicyclists

The bicycle box assigns priority to bicyclists, allowing them to get in front of the traffic queue

Signage alerting motorists to stop behind the bicycle box is advised

On a two-lane roadway the bicycle box can also facilitate left turning movements for bicyclists as well as through bicycle traffic

Motor vehicles must stop behind the white stop line at the rear of the bicycle box and may not turn right on red

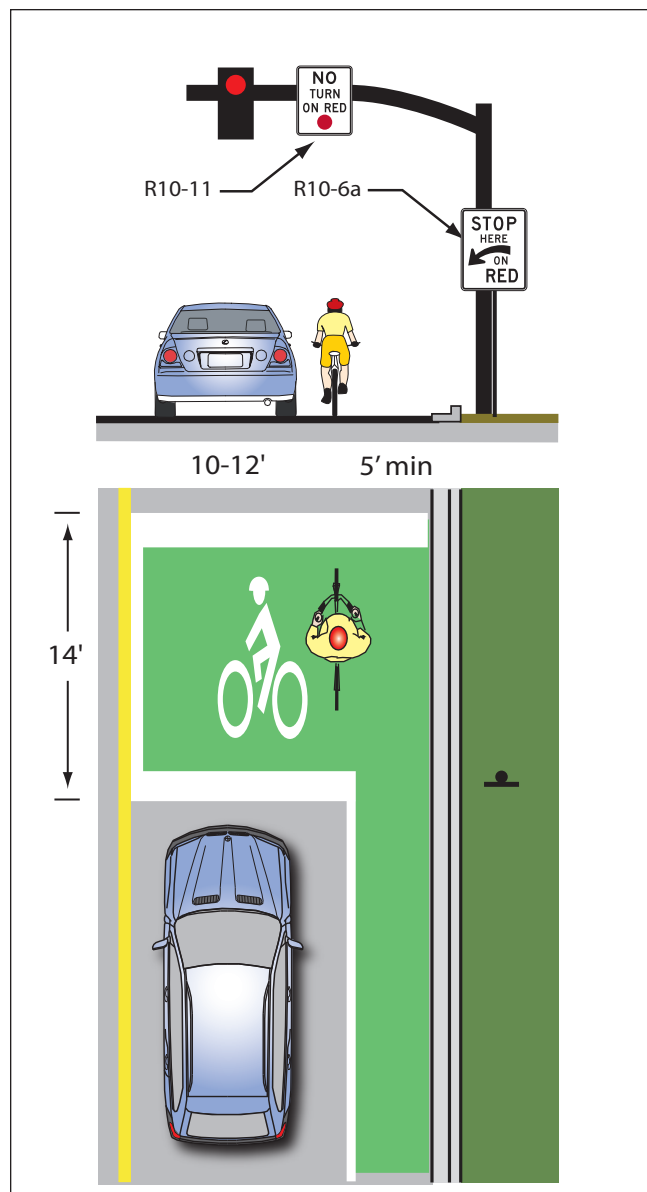
Where bicyclists have no need or have restricted access it may not be necessary to restrict right turns on red.

In these limited cases a vehicle right-turn only lane may be provided to the outside of the bicycle box.

At multi-lane bicycle boxes there can be a safety issue if a bicyclist is using the bicycle box to maneuver for a left turn just as the signal turns green. This would put the cyclist possibly in the path of an approaching vehicle. It is recommended that installations wider than one lane across from the access point to the bicycle box be studied carefully before installation

Guidance

This treatment is not currently present in any state or federal design standards.



Recommended Design

5. Bike Facility Design Options

Raised Bicycle Lanes

Design Summary

Recommended Design With Parking

Bicycle Lane Width:

5 feet minimum without parking. Bicycle lane should drain to street. Drainage grates should be in travel lane

Mountable Curb Design:

Mountable curb should have a 4:1 or flatter slope and have no lip that could catch bicycle tires

Signage & Striping:

Same as standard bicycle lanes

Discussion

When placed next to parking, bike lane should be a minimum six feet wide and colored to clearly delineate cyclist travel areas from motor vehicle parking

Raised bicycle lanes have a mountable curb separating them from the adjacent travel lanes

Provide an element of physical separation from faster moving vehicle traffic

For drivers, the mountable curb provides a visual and tactile reminder of where the bicycle lane is

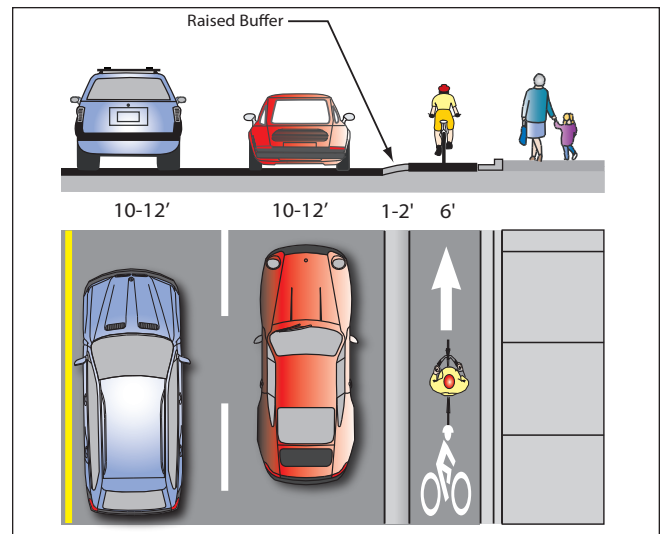
For bicyclists the mountable curb makes it easy to leave the bicycle lane if necessary, such as when passing another bicyclist

Raised bicycle lanes cost more than traditional bicycle lanes and typically require a separate paving operation but maintenance may cost less as the bicycle lane receives no vehicle wear and resists debris accumulation

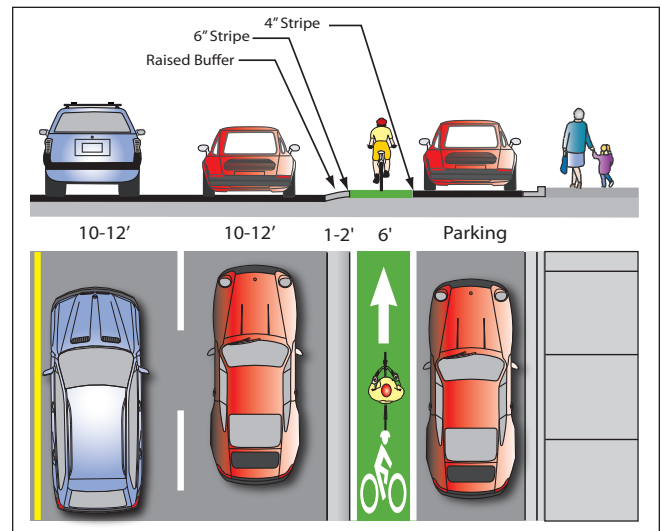
This treatment is less preferable than a cycle track, which eliminates more potential motor vehicle/cyclist conflict points

Guidance

This treatment is not currently present in any state or federal design standards.



Recommended Design Without Parking



Recommended Design With Parking

5. Bike Facility Design Options

Cycle Tracks

Design Summary

A cycle track is a hybrid type bicycle facility that combines the experience of a separated path with the on-street infrastructure of a conventional bicycle lane.

Cycle Track Width:

7 feet minimum to allow passing and obstacle avoidance

2 foot buffer between parking and cycle track to reduce door zone conflicts

Discussion

Provide space that is intended to be exclusively or primarily for bicycles, and is separated from vehicle travel lanes, parking lanes and sidewalks by pavement markings or coloring, bollards, curbs/medians or a combination of these elements

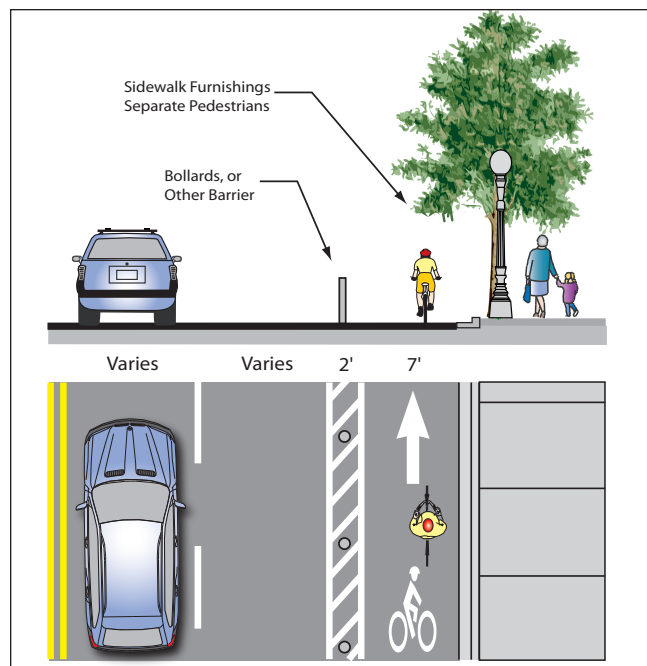
Should be one-way facilities, on one or both sides of a street, and are separated from vehicles and pedestrians

Place along slower speed urban/suburban streets with few driveways or other mid-block access points for vehicles

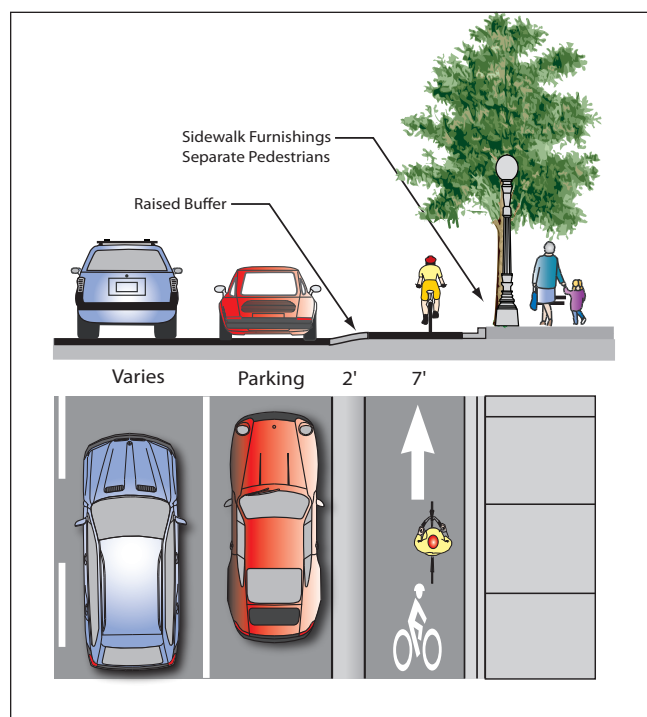
Careful considerations at intersections must be taken. Right turning motorists conflicting with cycle track users is the most common.

Special attention should be paid to maintenance issues when designing cycle tracks. In particular, cycle tracks should be designed so that they can be swept and plowed with standard maintenance equipment whenever possible.

Design Example



Recommended Design – No Parking



Recommended Design – On-Street Parking

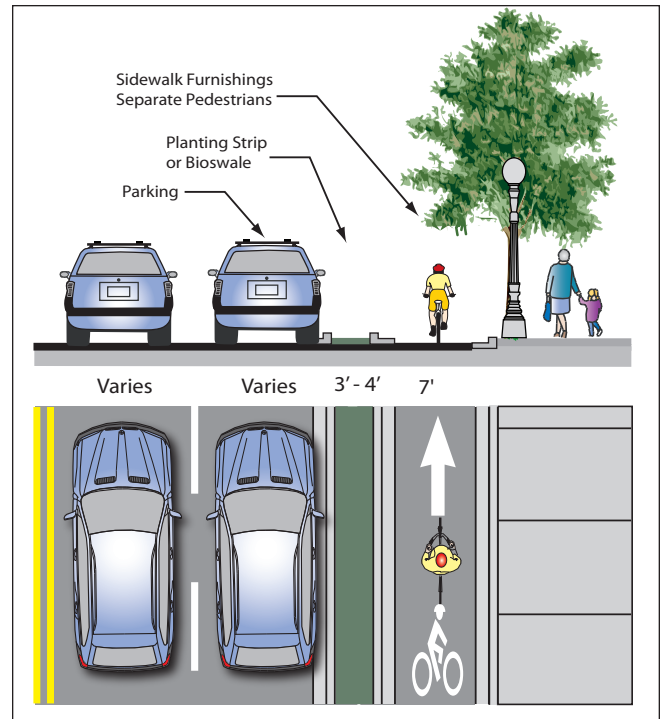
5. Bike Facility Design Options

Cycle Track, continued

Guidance

This treatment is not currently present in any state or federal design standards.

Suggested guidance is available in Cycle Tracks: Lessons Learned <http://www.altapanning.com/cycle+tracks.aspx>



Alternative Design – On-Street Parking